CONNECTICUT COASTAL BASIN
HAMDEN, CONNECTICUT

FARM BROOK SITE 2A DAM
CT 01546

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

SEPTEMBER 1981

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
September 1981	Inspection Report	

4. TITLE AND SUBTITLE
CT-01546 Farm Brook Site 2A Dam
Phase I inspection report
National dam inspection report

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
U.S. Army Corps of Engineers, New England Division

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers
New England Division
424 Trapelo Road
Waltham, MA 02254

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Cover program reads: Phase I inspection report, National Dam Inspection Program: however, the official title of the program is: National Program for Inspection of Federal Dams

14. ABSTRACT
Farm Brook Site 2A Dam, one of two dams (see Farm brook Site 2B Dam CT-01547 Report) impounding water at the site 2 reservoir consists of an earth embankment approximately 440 ft. long with top width of 14 ft. and a maximum height of 29 ft. The low level outlet for the project is the principal spillway which consists of a three stage reinforced concrete intake riser, a 30-inch reinforced concrete pipe and a 16 ft. long impact basin. In addition to the low-level outlet, there is a 210 ft. wide, grassed trapezoidal channel at the dam's west end serving as the emergency spillway.

Based on the visual inspection and review of available plans and reports, Farm Brook Site 2A Dam is judged to be in good condition; however, since the reservoir did not contain much impoundment at the time of inspection, any possible seepage conditions at the dam could not be ascertained.

15. SUBJECT TERMS
Dams, inspection, dam safety, Connecticut Coastal Basin, Hamden, Connecticut

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Matthew Connell
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	88	19b. TELEPHONE NUMBER *(include area code)* 978-318-8349

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

FARM BROOK SITE 2A DAM

CT 01546

CONNECTICUT COASTAL BASIN

HAMDEN, CONNECTICUT

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

IDENTIFICATION NO: CT-01546

NAME OF DAM: Farm Brook Site 2A Dam

TOWN: Hamden

COUNTY AND STATE: New Haven County, Connecticut

STREAM: Wilmot Brook

DATE OF INSPECTION: June 2, 1981

BRIEF ASSESSMENT

Farm Brook Site 2A Dam, one of two dams (See Farm Brook Site 2B Dam CT-01547 Report) impounding water at the Site 2 Reservoir consists of an earth embankment approximately 440 ft. long with top width of 14 ft. and a maximum height of 29 ft. The low level outlet for the project is the principal spillway which consists of a three stage reinforced concrete intake riser, a 30-inch reinforced concrete pipe and a 16 ft. long impact basin. In addition to the low-level outlet, there is a 210 ft. wide, grassed trapezoidal channel at the dam's west end serving as the emergency spillway.

Based on the visual inspection and review of available plans and reports, Farm Brook Site 2A Dam is judged to be in good condition; however, since the reservoir did not contain much impoundment at the time of inspection, any possible seepage conditions at the dam could not be ascertained.

As per the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, the Farm Brook Site 2A Dam is classified as 'Intermediate' in size with high hazard potential. A test flood equal to the probable maximum flood (PMF) was selected in accordance with the Corps of Engineers' Guidelines. The calculated test flood inflow of 6000 cfs, which includes a 2000 cfs breach flow from the Farmbrook Site 1 Reservoir, results in a routed outflow of 5980 cfs of which 4130 cfs and 1850 cfs respectively pass over the spillways of Site 2A and Site 2B dams. With the water level at the top of the Site 2A dam the maximum spillway capacity is 8700 cfs which is 210% of the Site 2A routed outflow.

The storage capacity of the reservoir at the top of the dam is 1190 ac. ft.

As the dam is a 'high' hazard potential a breach may result in excessive economic loss and endangerment of more than a few lives. Therefore, an emergency operation plan, including a downstream warning system should be prepared and implemented.

It is recommended that the owner employ a qualified registered engineer to do the following within two years of receipt of this report:

Inspect the dam during the time floodwater is impounded in the reservoir with particular attention to locating possible seepage.

In addition to these recommendations, there are also several remedial measures contained in Section 7 which should be carried out by the owner within two years receipt of this report.

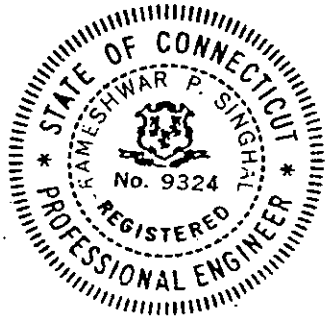
GOODKIND & O'DEA, INC.
AND
SINGHAL ASSOCIATES
(J.V.)

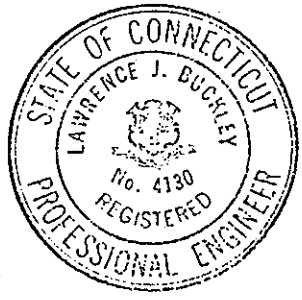
Ramesh P. Singhal

Ramesh Singhal, PH.D., P.E.
(Singhal Associates)

Lawrence J Buckley

Lawrence J. Buckley, P.E.
(Goodkind & O'Dea, Inc.)





PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the

present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there by any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the pulic. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

APPENDICES

NOTE:
OVERVIEW PHOTO TAKEN JUNE 2, 1981

GOODKIND & O'DEA INC.–SINGHAL ASSOCIATES(J.V.) ENGINEERS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

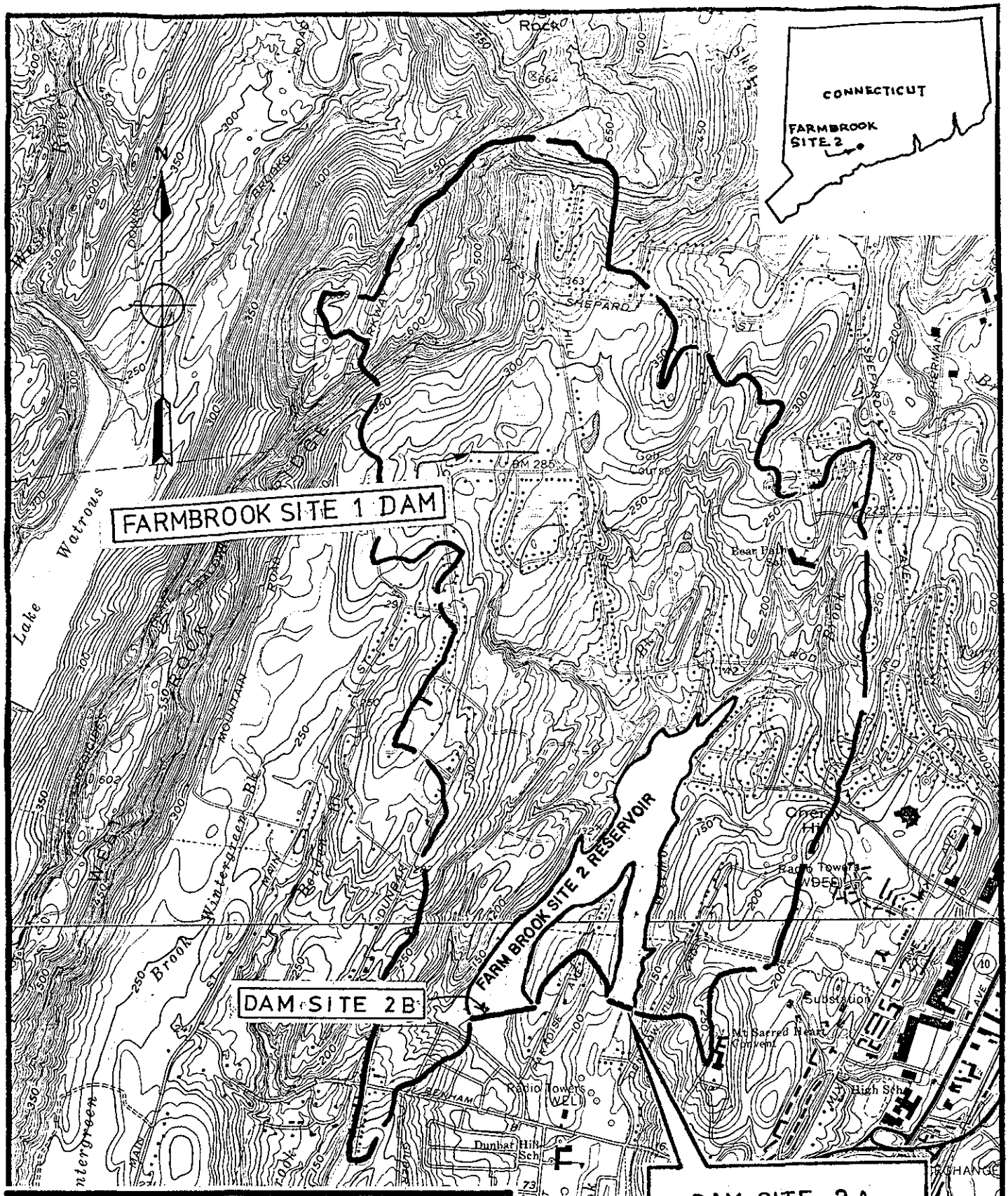
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

OVERVIEW PHOTO OF DAM

FARM BROOK SITE 2A DAM

HAMDEN, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE: NONE	
E.T.K.	W.J.W.	L.J.B.	DATE: SEPT., 1981	SHEET 1



GOODKIND & O DEA INC.– SINGHAL ASSOCIATES(J.V.) ENGINEERS		U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS	
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS			
LOCATION PLAN			
FARM BROOK SITE 2A DAM			
HAMDEN, CONN.			
NEW HAVEN, CT. 1967 / 1972 QUADRANGLE			
DRAWN BY	CHECKED BY	APPROVED BY	SCALE: 1" = 2000'
G.S.	R.S.	R.S.	DATE: SEPT. 1981 SHEET 2

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

PROJECT INFORMATION
Section 1

1.1 GENERAL

a. Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of Dams within the New England Region. Goodkind & O'Dea Inc., Hamden, Connecticut and Singhal Associates, Orange Connecticut (Joint Venture) have been retained by the New England Division to inspect and report on selected dams in the State of Connecticut. Authorization and notice to proceed were issued to Goodkind & O'Dea Inc. and Singhal Associates (J.V.) under a letter of June 22, 1981 from Colonel William E. Hodgson Jr., Corps of Engineers. Contract No. DACW 33-81-C-0022 Dated December 9, 1980 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

The purposes of the program are to:

1. Perform technical inspection and evaluation of non-federal dams to identify conditions requiring correction in a timely manner by non-federal interests.

2. Encourage and prepare the States to quickly initiate dam inspection programs for non-federal dams.

3. To update, verify and complete the National Inventory of Dams.

1.2 DESCRIPTION OF PROJECT

a. Location

The Farm Brook Site 2A Dam is situated on the Wilmot Brook in the watershed of West River. The confluence with the West River is approximately 3.5 miles downstream. Location of the project is 0.5 miles northeast of Dunbar Hill School and 0.4 miles north of the intersection of Benham Road and Denslow Hill Road. The geographic location of the site may be found on the New Haven Quadrangle Map with coordinates of Latitude N41° 22.2' and Longitude of W72° 56.6'.

b. Description of Dam and Appurtenant Structures

Farm Brook Site 2A Dam is one of two structures that retains floodwaters at the Site 2 Reservoir. The Site 2A dam is a grass-covered earth embankment, approximately 440 ft. long. Top width of the dam is 14 ft. with upstream and downstream slopes of 3 horizontal to 1 vertical and 2½ horizontal to 1 vertical respectively. The crest elevation of the embankment is 107.7' (all elevations in the report are referenced to NGVD) with a maximum height of 29 ft. Located under the downstream embankment is a 3 ft. wide foundation trench drain containing an 8" perforated pipe. The underdrain system outlets into the concrete impact basin through two 8" pipes. Centered

under the crest of the dam is a 12 ft. wide cutoff trench, approximately 4 ft. deep (See Sheet B-2 in Appendix B).

The principal spillway is a drop inlet structure consisting of a three stage reinforced concrete intake riser discharging into a 30" reinforced concrete pipe under the dam embankment. Approximately 152 ft. long, the pipe discharges into a reinforced concrete impact basin, 11 ft. wide and 16 ft. long. Downstream of the impact basin the channel is riprapped for a distance of 25 ft. of which the first 15 ft. is grouted.

The intake riser consists of a low and high level orifice and two riser crest weirs which are at invert elevations of 80.5', 83.5' and 96.5' respectively. A sliding gate, which normally remains in the closed position, is situated at the 15" x 15" low level orifice. Trash racks are located at both the riser crest weirs and at the 2' x 2' high level orifice. In addition, the upstream slope in the vicinity of the intake riser is protected with 18" grouted riprap up to an elevation of 87.0' (See sheet B-2 in Appendix B).

Abutting the west end of the dam embankment is a grassed trapezoidal channel, 210 ft. wide at the control section, which serves as the emergency spillway. With a crest elevation of 102.0', this control section is 5.7 ft. below the top of dam. As shown on the general plan in Appendix B, the approach channel is at a grade of +2.0% whereas the discharge channel is at a -2.5% grade. The two staged, 3 horizontal to 1 vertical cut slope along the west edge of the spillway have several rock and

grassed line diversion channels to deter runoff erosion (See general plan in Appendix B). In addition, there is also a low dike approximately 210 ft. in length along the east side of the discharge channel. As shown on Sheet B-3 in Appendix B, the crest is 10 ft. wide with a crest elevation varying from 107.7' at the level section to 102.0' at the south end. The earthen embankment has side slopes of 3 horizontal to 1 vertical with the west slope riprapped.

c. Size Classification 'Intermediate'

According to the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams, a dam is classified as 'intermediate' if either the height lies between 40 ft. and 100 ft. or the storage is between 1,000 ac. ft. and 50,000 ac. ft. The Farm Brook Site 2A Dam has a maximum height of only 29 ft., but the maximum storage (up to the top of the dam) is 1,190 ac. ft. As such, it is classified as 'Intermediate' in size.

d. Hazard Classification 'High'

Based on the Corps of Engineers Recommended Guidelines for Safety Inspection of Dams, the hazard classification for the Farm Brook Site 2A dam is 'high'. A dam failure analysis indicates that a breach of the dam would result in a downstream flood flow of approximately 44,000 cfs causing a 17 ft. high wave of water to travel down the Wilmot brook and its over-banks on both sides. Continuation of valley flood routing through the brook shows that at the second cross-section located 2,000 ft. down from the dam, near the Benham Road crossing, the flow and wave heights are still as high as 40,000 cfs and 12 ft. respectively.

The depth of flow in the brook in the area of six houses shown in the drainage area map within the approximate flooding limits are 5.5 ft. (pre-failure) and 14 ft. (post-failure). These houses which are located on Parmalee Drive are not subject to flooding under test flood condition. Under dam failure condition, they will be flooded to depths of 1 to 3 feet above their first floor elevations.

The dam failure would result in flooding of additional houses and streets. There is potential for 'excessive economic loss' and possible loss of more than a few lives.

e. Ownership

The Farm Brook Reservoir and dams 2A and 2B are owned by:

The State of Connectcut
Department of Environmental Protection
State Office Building
165 Capitol Avenue
Hartford, Conn. 06115
Telephone: (203) 566-7244/7245

f. Operator

Mr. Victor Galgowski
Superintendent, Dam Maintenance
D. E. P. (Water Resources Unit)
165 Capitol Avenue
Hartford, Conn. 06115
Telephone: (203) 566-7244/7245

g. Purpose of Dam

The purpose of the dam is primarily for flood control.

h. Design and Construction History

The dam and appurtenant structures were designed in the year 1971 by the U. S. Department of Agriculture, Soil Conservation Service. The dam construction was completed in the year 1977.

i. Normal Operational Procedures

Operational procedures generally consists of surveillance during periods of unusually heavy runoff.

1.3 PERTINENT DATA

a. Drainage Area

The drainage area for the Site 2 Reservoir consists of 2.63 sq. miles of moderately sloping to rolling terrain, with an average slope of approximately 4.6% and elevations ranging from 110 ft. to 680 ft. MSL. Farmbrook Site #1, a 1115 ft. long and 11 ft. high earth dam is within the Site 2 drainage area as shown on the Location Plan. Several residential homes and town roads are also contained within the drainage area.

b. Discharge at Damsite

Two spillway facilities exist at the damsite. The principal spillway consists of a three stage reinforced concrete intake riser and a 152 ft. long 30" reinforced concrete pipe under the dam embankment. The emergency spillway is a trapezoidal grassed channel, 210 ft. wide at the control section and located at the west end of the dam.

1. Outlet works (conduits size): 1-30" RCP

Low level orifice invert elevation:	80.5
High level orifice invert elevation:	83.5
Inlet weirs, crest elevation:	96.5
Discharge capacity at test flood elevation:	120 cfs
elevation:	105.4

2. Maximum known flood at damsite: Unknown

	Principal Spillway (cfs)	Emergency Spillway (cfs)	Total (cfs)
3. Ungated spillway capacity at top of dam:	130	8,570	8,700
Elevation:			107.7

	Principal Spillway (cfs)	Emergency Spillway (cfs)	Total (cfs)
4. Ungated spillway capacity at test flood elevation: Elevation	120	4010	4130 105.4
5. Gated spillway capacity at normal pool elevation:			N/A
6. Gated spillway capacity at test flood elevation:			N/A
7. Total spillway capacity at test flood elevation: Elevation:	120	4010	4130 105.4
8. Total project discharge at top of dam: Elevation:	130	8570	8700 cfs 107.7
9. Total project discharge at test flood elevation: Elevation:	120	4010	4130 cfs 105.4

c. Elevation (NGVD)

1. Streambed at toe of dam	79.0
2. Bottom of cutoff:	73.0
3. Maximum tailwater:	N/A
4. Normal pool:	83.5
5. Full flood control pool:	102.0
6. Spillway crest:	102.0 (Emergency) 96.5 (Principal - high level inlet weir)
7. Design surcharge (original design):	105.7
8. Top of dam:	107.7
9. Test flood surcharge:	105.4

d. Reservoir Length in Feet

1. Normal pool:	1000
2. Flood control pool:	4,900

3.	Spillway crest pool Emergency spillway: Principal spillway (Riser crest weirs):	 4,900 4,600
4.	Top of Dam:	5,300
5.	Test flood pool:	5,200

e. Storage (Acre-Feet)

1.	Normal pool:	10
2.	Flood control pool:	720
3.	Spillway crest pool Emergency spillway: Principal spillway (Riser crest weirs):	 720 348
4.	Top of Dam:	1,190
5.	Test flood pool:	960

f. Reservoir Surface - Acres

1.	Normal pool:	5
2.	Flood control pool:	80
3.	Spillway crest Emergency spillway: Principal spillway (Riser crest weirs)	 80 56
4.	Top of dam:	120
5.	Test flood pool:	103

g. Dam

1.	Type:	Earth Embankment
2.	Length:	440 ft.
3.	Height:	29 ft.
4.	Top width:	14 ft.
5.	Side slopes:	3 hor. to 1 vert. (upstream) 2½ hor. to 1 vert. (downstream)

6.	Zoning:	None. Entire Section made of compacted fill.
7.	Impervious core:	N/A
8.	Cutoff:	12 ft. wide, 4 ft. deep cutoff trench
9.	Grout curtain:	N/A
10.	Other:	N/A

h. Diversion and Regulating Tunnel — N/A

i. Spillway

		Principal Spillway	Emergency Spillway
1.	Type:	Drop inlet structure consisting of a three stage reinforced concrete intake riser with a 30" reinforced concrete pipe.	Grassed trapezoidal channel
2.	Length of crest:	15 ft. (high level inlet weir)	210 ft. at the control section
3.	Crest Elevation:		
	w/flashboards:	N/A	N/A
	w/o flashboards:	96.5 (high level inlet weir)	102.0
4.	Gates:	N/A	N/A
5.	Upstream Channel:	Wilmot Brook (natural channel)	N/A
6.	Downstream Channel:	16 ft. long impact basin leading to natural channel, rip-rapped for 25 ft.	N/A
7.	General:	N/A	N/A

j. Regulating Outlets

1.	Invert	80.5
2.	Size	15" x 15"
3.	Description	Low level outlet which normally remains closed.
4.	Control Mechanism	Stainless Steel sliding gate located along inner wall of intake riser with gate stem extending to top of structure
5.	Other	N/A

ENGINEERING DATA

Section 2

2-1 Design Data

In 1971, the United States Department of Agriculture, Soil Conservation Service prepared a design report and design plans for Farm Brook Site 2 which consists of two dams, Site 2A and Site 2B. The design report entitled "Farmbrook Site No. 2" includes hydrologic and hydraulic data and computations, geology report, soil testing report and dam stability analysis. Several pages of the report and logs of two typical drill holes pertaining to Site 2A Dam have been copied and are given as part of Appendix B.

2.2 Construction Data

"As-Built" drawings entitled "Farm Brook Watershed Project, Floodwater Retarding Dam No. 2" were completed by the U.S. Conservation Service. These drawings have been reviewed and found to show good agreement with the visual inspection. Certain details have been copied from the drawings and are included in Appendix B.

2.3 Operational Data

A small pool normally exists behind the dam embankment; however, water level readings are not taken at these times, nor during flood impoundment. Although there are no formal operation records, a log book of the dam is kept by the State of Connecticut Department of Environmental Protection. According to the owner, the reservoir has never risen to the level of the emergency spillway crest. An Operation and Maintenance Handbook, which was prepared by the U.S. Soil Conservation

Service, is available.

2.4 Evaluation

a. Availability

Available existing data was provided by the State of Connecticut Department of Environmental Protection who are owners and the U.S. Soil Conservation Service who designed and constructed the dam. Location of the available data is given in Appendix B.

b. Adequacy

The engineering data available, when coupled with visual inspection, were generally adequate to perform an assessment of the dam.

c. Validity

A comparison of record data and visual observations reveals no significant discrepancies in the record data.

VISUAL INSPECTION
Section 3

3.1 Findings

a. General

On June 2, 1980, engineers from Goodkind & O'Dea Inc. and Singhal Associates performed a formal field inspection of Farm Brook Site 2A Dam. Detailed checklists included in Appendix A were utilized for the inspection of the dam and spillways. In addition, photographs showing these dam features and the problem areas were taken during the inspection and are given in Appendix C along with the photo location plan.

The general condition of the project is good with some areas requiring minor maintenance and/or monitoring. At the time of the inspection, the water level in the reservoir was 83.6' which was one-tenth of a foot above the high orifice invert elevation.

b. Dam

The dam consists of an earthfill embankment with a foundation drain trench underlying the downstream slope. As shown in Photos 1 & 2, the alignment appeared good with no sign of vertical or horizontal movement. Minor rutting was noted along the crest of the dam, resulting from vehicular traffic (see Photo 1). The exposed earth areas associated with the rutting were stable with no evidence of erosion. Trespassing was also observed along the upstream and downstream slopes (see Photo 3) of the dam embankment. Two wheeled vehicles, such as motorcycles have created bare earthen trails due to continuous usage. Although the vegetation has been removed, there was no sign of erosion at these areas. With the exception of

the vehicular trails, the entire earth embankment is covered with a stable growth of vetch with no evidence of sloughing or erosion.

There was no indication of any downstream seepage; however, since the reservoir water level was low, no conclusive determination of the seepage conditions could be made at that time. The two 8 inch foundation drain outlets were approximately three-quarters full of water, which could have obscured any minor seepage flow.

Located along the toe of the upstream slope is a stable rock lined diversion which is shown on the general plan in Appendix B. In addition to the diversion, a slope trench drain with 4 inch plastic tubing is situated at the east end of the dam. This underdrain system controls groundwater seepage originating from the hillside east of the dam. The trench outlets through a 4 inch cast iron pipe which was covered and could not be located during the inspection.

c. Appurtenant Structures

Principal Spillway

Impounded stormwater runoff and the normal flow to the reservoir passes under the dam embankment through the principal spillway. Consisting of a reinforced concrete intake riser, 30" pipe and impact basin, the principal spillway is generally in good condition. Numerous pock marks, possibly resulting from bullet impacts, were located on the north, south and east sides of the intake riser. Structurally sound and well painted, the steel trash racks at the high orifice and the crest riser were clean and free of debris as shown in Photo 5. Last operated in 1979, the slide gate at the low orifice was closed and fully submerged, preventing its inspection. Immediately south of the riser, the grouted riprapped area was in good condition with no indication of any cracking or failure.

Situated on the downstream side of the dam is the reinforced concrete impact basin which is in good condition. As shown in Photos 6 and 7, the chain linked fence around the impact basin outlet, was tilted. The concrete at the base of the east and west center posts was cracked causing this problem. Directly downstream of the impact basin the riprapped areas, grouted and non-grouted, were stable and in good condition.

Emergency Spillway

Abutting the west end of the dam, is the emergency spillway which is covered with a stable growth of vegetation. As shown in the Overview Photo and Photos 1, 2, 4 and 8, several motorcycle trails were noted along the grass covered spillway floor and the cut slopes which were protected with grass and vetch. The trails have been well ridden as indicated by the bare earthen areas. As noted on the general plan in Appendix B, one segment of the trail on the lower cut slope showed signs of minor erosion. The remaining vehicular paths appeared stable with no evidence of any detrimental erosion.

Several rock lined and grass lined diversions are located along the cut slope and approach channel floor as indicated on the general plan in Appendix B. These diversions were in good condition with stable rock and grass linings. The slope drain inlets on the cut slope and the outlet at the spillway channel floor were dry and clean.

As shown in the Overview Photo, a small earthfill dike is located along the east side of the emergency spillway. The west embankment slope is protected by a stable riprap lining whereas the crest and east slope are covered by a stable growth of vetch.

d. Reservoir Area

Farm Brook Site 2A Reservoir generally consists of grasslands and wooded areas. The normal pool level is at the high orifice invert elevation resulting in a small pool area at the dam and wetlands upstream, which serves as a wildlife area (See Photo 4). Several residential homes border the reservoir area which is part of the Farm Brook Site 2 Watershed Project.

e. Downstream Channel

As shown in Photo 7, the channel downstream from the principal spillway is in good condition with no accumulation of debris. The riprapped areas immediately beyond the impact basin were stable with no evidence of failure. Minor brush growth and a few overhanging trees were noted along the channel farther downstream.

3.2 Evaluation

Based upon the visual inspection, the condition of the dam and appurtenances was good with no observed stability problems. The exposed earthen vehicular trails on the crest and slopes of the dam were the primary problem noted. Continued travel on these trails could potentially lead to erosion, decreasing the dam stability. During the inspection, there was no indication of any downstream seepage; however, the reservoir water level was only four feet above the downstream channel water elevation. Thus, a conclusive determination of the seepage conditions could not be made at that time.

OPERATIONAL AND MAINTENANCE PROCEDURES
Section 4

4.1 Operational Procedures

a. General

The operational procedures generally consist of dam surveillance during periods of unusually heavy runoff. At these times, inspections of the dam and its features are completed by a representative of the State of Connecticut Department of Environmental Protection. Trash racks at the intake riser are kept free of brush and debris to prevent unnecessary water level build-up. Although water level readings are not taken, informal records of the project are registered in a log book.

Normally in the closed position, there is a sliding gate mechanism situated at the low level orifice of the intake riser. The gate was last opened in 1979 to lower the reservoir level, which was necessary for removal of tree stumps and debris.

b. Description of any Warning System in Effect

There are no warning systems in effect.

4.2 Maintenance Procedures

a. General

The State of Connecticut Department of Environmental Protection is responsible for the maintenance of the dam and appurtenances. On an annual basis, the dam embankment and emergency spillway are mowed by the State. In addition, brush and debris are cleared from the upstream reservoir area and downstream channel as necessary.

Representatives from the State of Connecticut Department of Environmental Protection and the U.S. Soil Conservation Service inspect Farm Brook Site 2A Dam annually. During this inspection, the general condition of the dam and appurtenant structures is assessed, followed by recommendations for necessary repairs and/or maintenance.

b. Operating Facilities

Construction, operation and structural repair of the flood control works is the responsibility of the owner, the State of Connecticut, Department of Environmental Protection.

4.3 Evaluation

Operational and maintenance procedures are generally satisfactory, but some areas do require improvement. A general Operation and Maintenance Handbook, which is adequate for this dam, was prepared by the U.S. Soil Conservation Service. However, records of maximum pool levels during flood impoundments and a downstream emergency warning plan should be developed by the State of Connecticut Department of Environmental Protection. A comprehensive program of inspection to be undertaken on a biennial basis by a registered professional engineer qualified in dam inspection should also be instituted by the State.

EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES
SECTION 5

5.1 GENERAL

Farm Brook Reservoir was created in the late 1970's to reduce potential flooding in the watershed area of West River. Detailed designs were prepared by the U.S. Department of Agriculture, Soil Conservation Service.

The reservoir has a contributory drainage area of 2.63 square miles which is moderately sloping to rolling terrain with average slope of approximately 4.6%. Part of this area is developed with several town roads and numerous residential homes. Spillways at Farm Brook Site 2A and Site 2B dams both function together to pass the floodwaters from the reservoir to the downstream areas.

There is a 30-inch outlet pipe under Farm Brook Site 2A dam, and a three-stage reinforced concrete intake riser upstream acting as the principal spillway and a trapezoidal grassed channel, 210 ft. wide at the control section which serves as the emergency spillway. With the pool level at the dam crest, the total spillway capacity is 8700 cfs whereas, the test flood elevation 105.4' the capacity is 4130 cfs. The crest elevation of the dam is 107.7' which is 5.7 ft. higher than the emergency spillway crest elevation of 102.0'.

5.2 DESIGN DATA

Detailed plans, the as-built drawings and the design report are available at the U.S. Department of Agriculture, Soil

Conservation Service in Storrs, Connecticut. Required design data are contained therein.

The design test flood inflow for the Farm Brook Reservoir was 7200 cfs and the routed outflow was 5200 cfs with the design highwater elevation in the reservoir computed to be 105.7' giving a freeboard of 2.0 ft.

5.3 EXPERIENCE DATA

No records are kept of reservoir levels during the times that water is impounded in the Farm Brook Reservoir.

5.4 TEST FLOOD ANALYSIS

Based on the dam failure analysis, the Farm Brook Reservoir Site 2A Dam is classified as being 'high' hazard potential in accordance with the Corps of Engineers' Recommended Guidelines for Safety Inspection of Dams. The test flood should be equal to the probable maximum flood (PMF) which was accordingly adopted for analysis.

An inflow peak rate of runoff was calculated for 2.63 square miles of watershed area using a runoff coefficient with a value intermediate between the 'flat & coastal' and 'rolling' terrain curves. The peak inflow rate of 1500 cfs per square mile (CSM) was accordingly adopted resulting in a runoff of 4000 cfs. A dam failure outflow of 2000 cfs from the Farm Brook Site 1 project was added to this value resulting in a total PMF of 6000 cfs.

A triangular hydrograph was constructed using the methodology given in the 'Hydrology, Section 4, SCS National Engineering Handbook'. The peak inflow rate of 6000 cfs with a total runoff of 19.0 inches for the PMF were used to construct the inflow hydrograph.

Flood routing through the reservoir was completed with an initial water elevation of 96.5' which was at the crest of the intake riser weir at the principal spillway. The test flood produced a routed outflow discharge of 5980 cfs, of which 4130 cfs will pass over the Site 2A spillways and 1850 cfs over the Site 2B spillways.

The routed outflow of 4130 cfs is considerably less than the maximum spillway capacity of 8700 cfs at Site 2A, the latter being 210% of the former. Considering the peak test flood pool elevation of 105.4', freeboard to the top of the dam is 2.3 ft.

5.5 DAM FAILURE ANALYSIS

A dam failure analysis was made in accordance with the Corps of Engineers' Guidelines. Failure was assumed with the water level at the test flood elevation of 105.4'. Assuming a dam breach 176 ft. wide (40% of dam length) and 28 ft. high, the peak release rate was 44,000 cfs.

The height of the flood wave was approximately 17 ft. at the first cross-section (station 3+0). A cross-section 2000 ft. down from the dam was also analyzed. Flood routing computations were done taking into consideration the available valley storage. The resulting flood elevations and the values of the routed flood flows are given in Appendix D. At the second cross-section, (Station 20+0) the flow is 40,000 cfs and the wave height 12 ft., which have considerable potential of causing substantial flooding

of heavily populated areas south of Benham Road.

The depths of flow in the brook in the area of six houses shown on the drainage area map within the approximate flooding limits, are 5.5 ft. (pre-failure) and 14 ft. (post-failure). These houses which are located on the Parmalee Drive are not subject to flooding under test flood conditions. Under dam failure condition they will be flooded to depths of 1 to 3 feet above their first floor elevations.

Many houses, streets and town roads will be flooded as a result of dam breach. The economic loss may be 'excessive' and 'more than a few lives' may be lost. As such, the Farm Brook Site 2A Dam is classified as 'high' hazard potential.

Dam breach calculations are included in Appendix D.

EVALUATION OF STRUCTURAL STABILITY
Section 6

6.1 Visual Observation

The visual inspection revealed no structural stability problems; however, an area of concern was noted. Several vehicular, bare earthen trails were observed on the crest and along the slopes of the dam embankment. Although there was no indication of erosion, the potential for such a problem exists if this vehicular trespassing continues.

During the inspection, there was no observed downstream seepage; however, the reservoir water level was only four feet above downstream channel level. Therefore, seepage that may exist when floodwater is impounded in the reservoir could not be observed.

6.2 Design and Construction Data

Review of the available data indicates that the dam and spillway were adequately designed for structural stability.

6.3 Post Construction Changes

Originally, a diversion channel was constructed in the upper reservoir area in conjunction with Farm Brook Site 2B Dam. Part of the original flow to Site 2A Dam was redirected to Site 2B Dam to balance the water inflow to their reservoir areas. Following all construction work, it was observed that the inflow to the Site 2A dam had been greatly decreased. Therefore, in the summer of 1978, a closure dike was built across the diversion channel and two short channels were excavated to redirect the brook flow to Site 2A Dam. The available data does not indicate

any other post construction changes.

6.4 Seismic Stability

The dam is located in Seismic Zone No. 1, and in accordance with Corps of Engineers guidelines, does not warrant further seismic analysis at this time.

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

Section 7

7.1 Project Assessment

a. Condition

As assessed by the visual inspection of the site, review of available data and past performance, the project appears to be in good condition. Although, there was no evidence of structural instability, there are areas requiring maintenance and/or monitoring.

Based on the "Preliminary Guidance for Estimating Maximum Probable Discharge" dated March, 1978, peak inflow to the Site 2 Reservoir is 6,000 cfs; peak outflow of the Site 2A Dam is 4,130 cfs with the water level 2.3 feet below the crest of the dam. With the pool level to the top of dam the spillway capacity is 8,700 cfs, which is equivalent to 210% of the routed test flood outflow.

b. Adequacy of Information

The information available is such that an assessment of the condition and stability of the project can be made.

c. Urgency

It is recommended that the measures presented in Section 7.2 and 7.3 be implemented within two years of the owner's receipt of this report.

7.2 Recommendations

It is recommended that the owner employ a qualified registered engineer to:

1. Inspect the dam during the time that floodwater is

impounded in the reservoir with particular attention to locating possible seepage.

The owner should implement the recommendations of the engineer.

7.3 Remedial Measures

a. Operation and Maintenance Procedures

The following measures should be undertaken by the owner and continued on a regular basis.

1. Develop and implement a downstream warning system to be used in case of emergencies at the dam.
2. Record maximum pool levels during flood impoundment for future reference.
3. Institute a comprehensive program of inspection to be undertaken on a biennial basis by a registered professional engineer qualified in dam inspection. Inspection of the project should be conducted in the Spring at a time when there is minimal vegetative cover.
4. Restore vegetation on the bare earthen vehicular trails along the dam embankment and emergency spillway.
5. Repair concrete at fence post foundation on concrete impact basin.
6. Clean and point pock marks on the concrete intake riser.
7. Expose and, if required, clean out the 4" cast iron slope drain outlet pipe at the east end of the dam.
8. Ensure the operability of the slide gate at the low level orifice on an annual basis.
9. Control access at project to discourage vehicular trespassing.

7.4 Alternatives

This study has identified no practical alternatives to the above recommendations.

APPENDIX A

INSPECTION CHECKLIST

VISUAL INSPECTION CHECK LIST
PARTY ORGANIZATION

OJECT Farm Brook Site 2A Dam

DATE June 2, 1981

TIME Afternoon

WEATHER Cloudy 70's

W.S. ELEV. 83.5' U.S. 79.5' DN.S. (MSL)

RTY:

	DISCIPLINE:
Wesley J. Wolf (WW)	Hydraulics & Survey
Larry J. Buckley (LB)	Geotechnical
Ramesh P. Singhal (RS)	Hydraulics
Gerald F. Buckley (GB)	Soils & Structures
Glenn Scallia (GS)	Structures

PROJECT FEATURE	INSPECTED BY
Dam Embankment (Earthfill)	WW, LB, RS, GB, GS
Principal Spillway - Intake Riser	WW, LB, RS, GB, GS
Principal Spillway - Impact Basin	WW, LB, RS, GB, GS
Emergency Spillway	WW, LB, RS, GB, GS

PERIODIC INSPECTION CHECK LIST

PROJECT Farm Brook Site 2A Dam DATE June 2, 1981

PROJECT FEATURE Earthfill Dam NAME W/W, LB, RS, GB, GS

DISCIPLINE _____ NAME _____

AREA ELEVATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	107.7' (MSL)
Current Pool Elevation	83.6' (MSL)
Maximum Impoundment to Date	Unknown
Surface Cracks	None Observed
Pavement Conditions	N/A
Movement or settlement of crest	Minor rutting, exposed earth
Lateral movement	None Observed
Vertical alignment	Good
Horizontal alignment	Good
Conditions at abutment & at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	N/A
Trespassing on Slopes	Motorcycle trails - Bare Earth. No erosion
Sloughing or Erosion of Slopes or Abutments	None Observed
Rock Slope Protection-Riprap Failures	Grouted riprap at Risen & Impact Basin in good condition
Unusual Movement or Cracking at or Near Toes	None Observed
Unusual Embankment or Downstream Seepage	None Observed
Piping or Boils	None Observed
Foundation Drainage Features	2 - 8" outlet pipes at impact basin were 3/4 full of water.*
Toe Drains	N/A
Instrumentation System	N/A

* No signs of flow from outlets

PERIODIC INSPECTION CHECK LIST

PROJECT Farm Brook Site 2A Dam DATE June 2, 1981

PROJECT FEATURE Intake Riser & Upstream Reservoir NAME WW, LB, RS, GB, GS

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Upstream Reservoir Area Clean with no debris
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of concrete lining	
Drains or Weep Holes	
b. Intake Structure	Concrete Intake Riser Good, except for ≈1" pock marks on N, S, & E sides of riser. Appear to be bullet holes
Condition of Concrete	
~~Stop Logs and Slots~~	Grouted riprap at riser in good condition Low level orifice was closed & under water

PERIODIC INSPECTION CHECK LIST

PROJECT Farm Brook Site 2A Dam DATE June 2, 1981

PROJECT FEATURE Impact Basin & Downstream Channel NAME WW, LB, RS, GB, GS

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Good, except it is cracked at the base of 4 fence poles resulting in a tilted fence
Rust or Staining	None
Spalling	None
Erosion or cavitation	None
Visible reinforcing	None
Any Seepage of Efflorescence	None Observed
Condition at Joints	Good
Drain Holes	Two 8" Foundation outlet pipes - 3/4 full of water *
Channel	
Loose Rock or Trees Overhanging Channel	None
Condition of Discharge Channel	Good - grouted riprap & ungrouted riprap was stable. No signs of erosion

* No evidence of seepage flow.

PERIODIC INSPECTION CHECK LIST

PROJECT Farm Brook Site 2A Dam DATE June 2, 1981

PROJECT FEATURE Emergency Spillway NAME WW, LB, RS, GB, GS

DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel (Before Crest)	
General Condition	Stable growth of grass - Good
Loose rock overhanging channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Motorcycle trails - Bare Earth
b. Weir and trailing walls	N/A
General Condition of Concrete	
Rust or Staining	
Spalling	
Any Visible Reinforcing	
Any Seepage or Efflorescence	
Drain Holes	
c. Discharge Channel (After Crest)	
General Condition	Good, stable growth of grass
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Channel	Motorcycle trails - Bare Earth
Other ~~Obstructions~~	Motorcycle trails on west cut slope - minor erosion minor sloughing of upper cut slope. Dike on East side is in good condition - stable riprapped slope.

APPENDIX B

ENGINEERING DATA

ENGINEERING DATA CHECKLIST

ITEM	AVAILABILITY	LOCATION
LOCATION MAP	Available	USGS Map
AS-BUILT DRAWINGS	Available	U.S. Soil Conservation Service Storrs, CT.
HYDROLOGIC & HYDRAULIC DATA	Available in Design Report	
SOIL BORINGS	Available in Design Report	
SOIL TESTING	Available in Design Report	
GEOLOGY REPORTS	Available in Design Report	
CONSTRUCTION HISTORY	Not Available	
OPERATION RECORDS	Not Available	
INSPECTION HISTORY	Available	State of Connecticut Department of Environmental Protection
DESIGN REPORT	Available	U.S. Soil Conservation Service Storrs, CT.
DESIGN COMPUTATIONS		
HYDROLOGIC & HYDRAULIC	Available in Design Report	
DAM STABILITY	Available in Design Report	
SEEPAGE ANALYSIS	Available in Design Report	

LOCATION

This floodwater retarding site is located on Farm Brook in the Town of Hamden, Connecticut, and consists of two individual dams. Site 2A is located on Farm Brook on the east side of Paradise Avenue approximately 2000 feet north of Benham Street. Site 2B is located on a tributary of Farm Brook on the west side of Paradise Avenue approximately 500 feet north of Cooper Lane. Refer to sheet 3 of this report for the site locations referenced to the USGS New Haven Quadrangle.

DESIGN

This structure is the main floodwater retarding structure proposed for this watershed. It is in series with an upstream, Class b, multiple-purpose structure. It will retard the runoff from a storm which has a frequency in excess of 100-years without discharge occurring through the emergency spillway.

Elevations of the various structural elements and the related determining factors are listed on sheet 5 of this report. The emergency spillway crest elevation was established approximately 3 feet above the routed peak elevation due to physical limitations at the dam sites.

The design of Site 2 neglected any beneficial effects induced by Site 1, as Site 1 is a Class b structure. However, the effect of a failure at Site 1 due to the occurrence of a Class c emergency spillway design storm on the watershed was considered during the design of Site 2.

A connecting channel from Farm Brook directed toward Site 2B will aid in the simultaneous filling of the two flood pools. It will also aid in preventing flow across Paradise Avenue at the Farm Brook crossing due to the more frequent, short-duration storms.

REFERENCES

Criteria and procedures used in this design are given in the following Soil Conservation Service Publications:

National Engineering Memorandum	No. 27	Limiting Criteria for the Design of Earth Dams
	No. 50	Drop Inlet Spillway Standards
	No. 4	Hydrology
	No. 5	Hydraulics

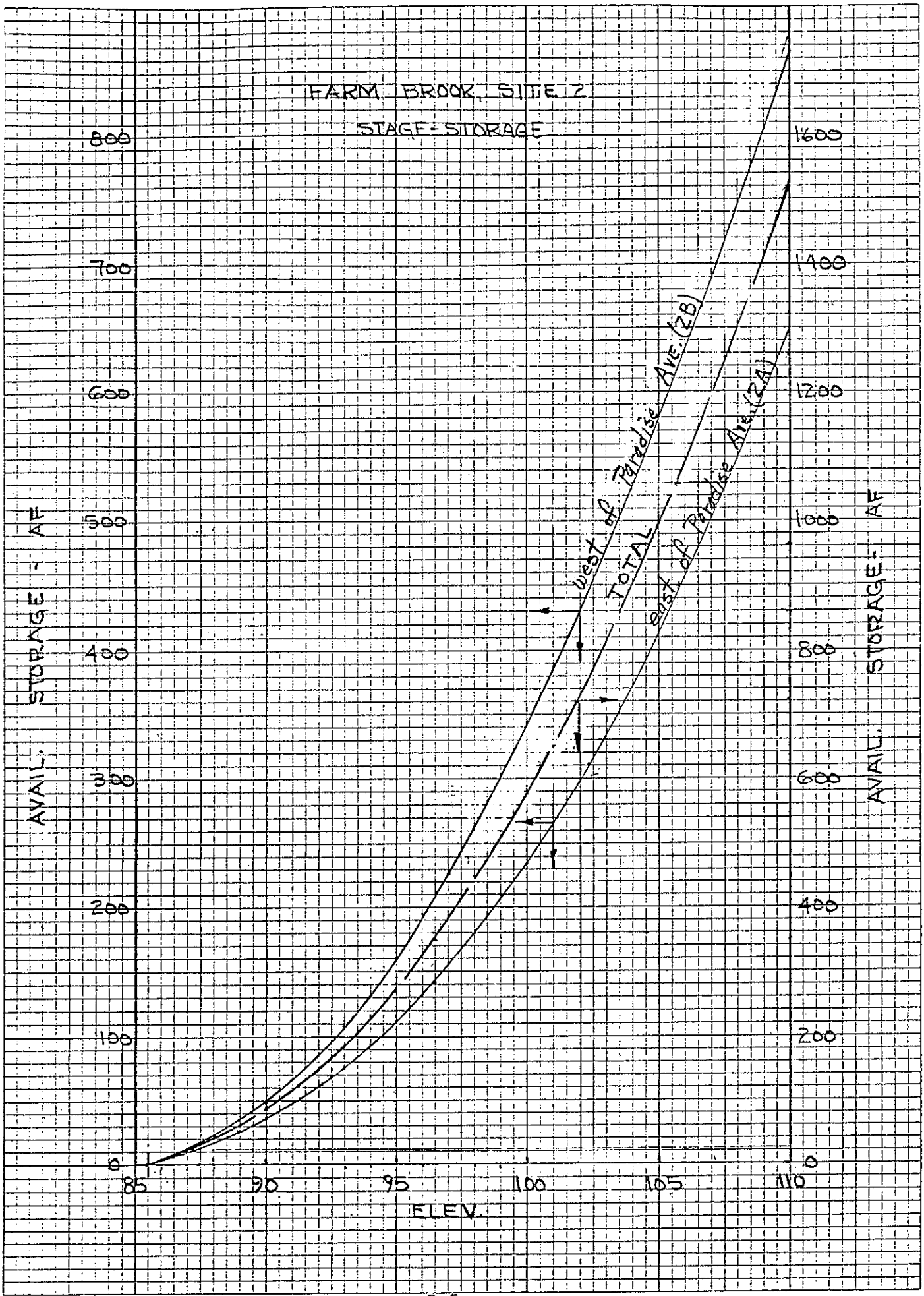
HYDROLOGIC CRITERIA AND ROUTING RESULTS

ELEMENT OF STRUCTURE	DETERMINING FACTOR	ELEVATION	SURFACE AREA ACRES	STORAGE		INFLOW		PEAK OUTFLOW C. F. S.
				ACRE-FEET	INCHES*	VOLUME INCHES	PEAK RATE C. F. S.	
INVERT OF ORIFICE	50-yr. Sediment accumulation	85.5	12.5	28	0.20	-	-	-
CREST OF RISER	100-Yr.,6-hr. Storm	96.5	56.0	348 1/	2.48	2.81	1,375	105
CREST OF EMERGENCY SPILLWAY	100-yr.,10-day Storm	99.3	70.8	537 1/	3.83	8.63	1,651	186
	(Crest elevation used)	102.0	80.1	720 1/	5.14	8.63+	1,651+	201
DESIGN HIGH WATER	16.5" rainfall, 2/ 6-hr. duration	105.7	104.7	890 1/	6.35	15.0	7,189	5,200
TOP OF DAM 3/	Design high water 2/ elevation plus 2 feet	107.7	-	1,190 1/	8.49 4/	21.9 4/	10,562 4/	8,374 4/

* Volume expressed in inches of runoff from controlled watershed area of 1,682 acres.
1/ Does not include sediment storage
2/ State of Connecticut Water Resources Criteria
3/ Maximum elevation as determined by (a) routing SCS Freeboard Storm
(b) design high water elevation plus 2 feet
4/ Value obtained from SCS freeboard routing.

FARM BROOK SITE 2 STRUCTURE SUMMARY TABLE

ITEM	UNIT	AS BUILT (EXISTING) Structure 2	AS BUILT (EXISTING) Structure 2A	AS BUILT (EXISTING) Structure 2B	WITH ORIFICE PLATE Structure 2	WITH ORIFICE PLATE Structure 2A	WITH ORIFICE PLATE Structure 2B
Orifice Size	Ft.	-	2 X 2	2 X 2	-	2 X 2	2 X 1
Orifice Weir Elevation	Ft.	-	83.5	85.5	-	83.5	85.5
Peak Outflow at Elevation 96.5' (Riser Crest)	cfs	129	67	62	98	67	31
Drawdown Time Elevation 102.0' - 96.5'	days	1.15	-	-	1.22	-	-
Drawdown Time Elevation 96.5' - 85.5'	days	-	-	2.61	-	-	5.45
Drawdown Time Elevation 102.0 - 85.5'	days	3.76	-	-	6.67	-	-


FARM BROOK, SITE 2
STAGE - STORAGE
AVAIL. STORAGE - AF
AVAIL. STORAGE - AF
ELEV.
West of Paradise Ave. (2B)
TOTAL
East of Paradise Ave. (2A)
0
100
200
300
400
500
600
700
800
0
200
400
600
800
1000
1200
1400
1600
85
90
95
100
105
110

UNITED STATES GOVERNMENT

Memorandum

: T. R. Wire, State Conservation Engineer, SCS, Storrs, Connecticut

DATE: April 9, 1968

: Lorn P. Dunnigan, Head, Soil Mechanics Laboratory, SCS, Lincoln, Nebraska

:CT: ENG 22-5, Connecticut WP-08, Farm Brook Watershed, Site No. 2A

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 1 sheet.
2. Form SCS-355, Triaxial Shear Test Data, 1 sheet.
3. Form SCS-352, Compaction and Penetration Resistance Report, 1 sheet.
4. Form SCS-357, Summary - Slope Stability Analysis, 2 sheets.
5. Form SCS-130, Drain Material, 1 sheet.
6. Investigational Plans and Profiles.

DISCUSSION

FOUNDATION

A. Bedrock: The bedrock at this site is sandstone. It occurs at depths of from about 5 feet to 14 feet on the abutments and at a depth of up to 25 feet in the floodplain.

B. Soil Classification: The soil overlying the bedrock on the abutments and in the floodplain is logged primarily as SM.

A composite sample of the typical soil in the upper 7 feet in the floodplain was submitted to the laboratory. This sample was obtained by compositing the split spoon samples from several test holes in the floodplain. The composite sample contains 15 percent gravel and 29 percent fines. The soil is classed as a nonplastic SM with an LL of 19.

C. Blow Count: The blow count ranges from 2 to 4 blows per foot in the surface 3 or 4 feet. Below this depth the blow count ranges from 8 to more than 100 blows per foot. The water table is very near ground elevation.

D. Permeability: Field permeability tests were made and the data are reported in the geology report.

EMBANKMENT

A. Classification: One borrow sample was submitted to the laboratory for testing. The sample reportedly is thought to be representative of the material in the emergency spillway and the material found on the whole right side. The sample submitted contains 18 percent gravel and 25 percent fines. It is nonplastic and has an LL of 16. It appears to be very similar to the sample submitted from the floodplain.

B. Compacted Density: A standard Proctor compaction test was made on the minus No. 4 fraction of sample 68W1881 (Field No. 130). The maximum dry density obtained is 124 pcf.

C. Shear Strength: A consolidated undrained triaxial shear test was made on the borrow sample. The test was made at 95 percent of standard Proctor density. The test specimens were soaked prior to testing. The shear strength values obtained are $\phi = 33^{\circ}$, c = 625 psf.

SLOPE STABILITY

The stability of the proposed 3:1 upstream slope and the 2 1/2:1 downstream slope was checked with a Swedish circle method of analyses. A phreatic line was assumed from emergency spillway elevation to a drain at c/b = 0.6. Shear strength values of $\phi = 33^{\circ}$, c = 625 psf were used to represent both the embankment and the foundation. The factors of safety obtained for the 3:1 upstream slope with full drawdown assumed is $F_S = 2.7$. The 2 1/2:1 downstream slope has a factor of safety of 2.7.

CONCLUSIONS AND RECOMMENDATIONS

A. Site Preparation: Based on description of material and blow count we suggest that the material that has a blow count of less than 4 blows per foot be stripped from the foundation. This is considered necessary because there is no test data available to evaluate the shear strength and the consolidation potential.

The water table is at or near ground surface at the present time and it appears that dewatering will be required.

B. Cutoff: We suggest a shallow keyway on the abutments to make sure that root holes, etc., are cut off. With the stripping suggested for the floodplain section, a cutoff trench may not be required. We suggest that the trench backfill be placed at a minimum of 95 percent of standard Proctor density. We suggest that the placement moisture content be wet of standard Proctor optimum.

3 -- T. R. Wire -- 4/9/68
Lorn P. Dunnigan
Subj: ENG 22-5, Connecticut WP-08, Farm Brook Watershed, Site No. 2A

C. Principal Spillway: The proposed location is on the right side of the floodplain near the base of the right abutment. The surface zone is low blow count material like described previously and we have suggested that this type of material be stripped from the entire foundation. The SM underlying the surface zone has blow count in excess of 17 blows per foot. Based on the blow count data we would expect very littl consolidation in the foundation for the fill height planned.

As pointed out previously the water table is at or near present ground level and dewatering will be necessary.

The backfill should be like that suggested for the cutoff trench.

The foundation material and the backfill material are non-plastic SM that is considered to be quite susceptable to piping, therefore, we suggest that the filter be enlarged to completely envelope the conduit. This is intended to reduce the possibility of piping along the conduit.

D. Drain: As mentioned previously the foundation and the embankment material are in the range of materials that are considered to be very susceptable to piping. For this reason we suggest a filter drain to provide a safe outlet for seepage. We don't have enough information to suggest the type of drain required. It appears however that the alluvium is quite uniform and that a trench drain located at about c/b = 0.6 may suffice.

The suggested filter limits based on the gradation of the samples submitted are shown on the attached form SCS-130.

As an alternative a double filter could be used if desired.

E. Embankment Design:

1. Placement of Material: The material available for the subject embankment is represented by sample 68W1881. We suggest that the embankment material be placed at a minimum of 95 percent of standard Proctor density with the control based on the minus No. 4 fraction. We suggest that the placement moisture content be on the wet side of standard Proctor optimum to provide as flexible a fill as possible.

2. Slopes: The proposed slopes have acceptable factors of safety.

3. Settlement: An overfill allowance of 0.5-foot is suggested to compensate for residual settlement.

Lorn P. Dunnigan

cc:
T. R. Wire, Storrs
W. M. Brown, Storrs
N. P. Tedrow, Storrs
N. F. Bogner, Upper Darby

GEOLOGY REPORT

FARM BROOK WATERSHED
HAMDEN, CONNECTICUT
SITE NO. 2A

Concurred by:

T. R. Wire
State Conservation Engineer
Storrs, Connecticut

Report No. CN-429A G
Prepared by:

W. M. Brown, Geologist
Storrs, Connecticut
January 1968

I. Introduction

A. General

State: Connecticut Location: New Haven County

Funds: CN-S (WP-08) CN-2007

Date: April, May 1967 Class: c

Equipment:

(1) CME (Central Mine Equipment) Model 55 Continuous Flight Auger;
(1) Acker Skid-Mounted Drill;
(1) John Deere Dozer;
(1) Track-Mounted Backhoe

Site Data:

Drainage Area:* 2.63 square miles
1683.2 acres

Type Structure: Compacted Earth

Height of Dam: 30 Feet

Length: 420 Feet

Volume of Fill: 25,000 Cubic Yards

Location of Emergency Spillway: Right Abutment

REFERENCE:	U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	DRAWING NO. CN 429A G SHEET 1 OF 8 DATE 1/68

GEOLOGY REPORT

Storage Allocation *

	Depth at Dam (feet)	Surface Area (acres)	Volume (ac. ft.)
Sediment:	5	4	28
Floodwater:	22	85	810

* Includes Site 2B

B. Surface Geology and Physiography

The site area is located in the lower portion of the Central Connecticut lowland in the "red rock" belt. The dam is one of two which constitute Site No. 2 and is the east structure having been designated Site 2A. The site which is of moderate relief is set in a region of comparable topographic expression. The site is located in a region which, having been completely glaciated, has a wide range of depositional features. Specifically at Site 2A, the centerline crosses a narrow valley whose bottom and abutments are composed of a heterogeneous till containing numerous cobbles and boulders. Immediate topography is controlled by the underlying bedrock configuration. This is particularly true of the west or right side of the site where the dam abutment and emergency spillway are located on a drumloidal hill whose major axis is approximately S 24° E. The left and right abutments have slopes of 25 and 18 percent respectively. The flood plain width at centerline of dam is about 180 feet and the present condition of the channel is aggrading.

The principal bedrock unit underlying the site is the New Haven Arkose of Triassic Age. Generally, this consists of red to pink fine to coarse grained sandstone, locally conglomeratic and occasionally interbedded with siltstone. No bedrock is exposed at the site. The bedrock however presumably conforms with the regional strike and dip pattern; that being a southeasterly strike with a dip of from 10 to 30 degrees to the east.

No structural features were observed or identified at the site through drilling which would adversely affect the design or construction of the proposed work of

GEOLOGY REPORT

Improvement. The streambanks are presently stable and no erosional problem is anticipated.

II. Subsurface Geology

A. Centerline of Dam

Six holes were drilled along the proposed centerline of the dam for foundation investigation and evaluation. All holes were taken to or penetrated bedrock. Thickness of till ranges from 10 to 14 feet in the abutments to about 10 feet in the valley bottom. Hole 43A on the left abutment (a 4 foot offset from an original on the centerline) penetrated 10 feet of till before encountering bedrock. Fragmental sandstone and boulders necessitated abandonment of the original hole. Holes 44, 45 and 302 were located along the centerline of dam and in the valley bottom. Hole 45 attained the greatest depth, that being 28.1 feet. Bedrock was not drilled but fragmental sandstone was abundant in an open-end drill rod having been advanced with a 300 pound hammer. The unconsolidated material which consists of fine to medium grained silty sands with associated silts, has an estimated medium relative density based on the blow-count from Standard Penetration-Resistance. The adjoining holes (44 and 322) had materials of comparable description but lacked the thickness before a denser zone was hit. The bedrock underlying the valley bottom is predominantly a fine grained-micaceous red sandstone belonging to the Triassic New Haven Arkose formation. The sandstone appears to be fairly sound with no significant voids being encountered.

Constant head permeability tests were also made in several of the centerline holes in the valley bottom. The purpose of thetests was to determine the coefficient of permeability (k) of the unconsolidated materials underlying the structure. The k values ranged from 0 in the zone tested in hole 44 to a maximum of 0.2 ft/day in hole 45. The following summarizes the constant head permeability test results:

GEOLOGY REPORT

Hole No.	Depth (feet)	k values (ft/day)
44	5-7	0
45	5-7	0.035
	10-12	0.07
	15-17	0.20
	20-22	0.035
322	5-7	0.072

Hole 42 was drilled on the right abutment on the centerline of dam. Till was hit at 5.0 feet and bedrock at 14.0 feet. No permeability test was performed because of the relative density and character of the abutment material. Hole 220 which is at the approximate inner limit of the emergency spillway cut is also on the centerline of dam at the end of the embankment. About 10 feet of unconsolidated material was drilled before soft, weathered sandstone was reached. The bedrock was not cored with a rock bit; however, 5 feet of penetration was made into the rock with the hydraulic power-auger.

Groundwater was at a consistent elevation in these holes drilled in the valley bottom. Groundwater levels were at or within 1 foot of existing ground surface. In the abutments, the depth to groundwater was 4.3 feet in hole 43A and 10 feet in hole 42. Surface seepage was conspicuous on the left side at the approximate break of slope of the valley wall and valley bottom. The seep zone was contained within centerline stations 3+00 to 3+20. The inflow was sufficient to provide a sump for drill hole 44 when a 1 to 2 foot cut was made with a small dozer. The apparent direction of groundwater movement in this case was from the valley wall to valley bottom.

B. Centerline of Outlet Structure

The principal conduit is to be located on the right side of the valley at the break of slope of the valley wall and floor. Five holes were drilled along the centerline of the structure to evaluate foundation conditions. Two

GEOLOGY REPORT

holes (320 and 321) were located under the proposed upstream limits of the embankment; 322 was located at the intersection of the centerline dam and principal spillway; and two holes (323 and 324) under the downstream portion of the dam.

Hole 320 was taken to a depth of 19.8 feet at which point no further advance of the casing could be made. Materials were primarily a fine to medium grained sand, poorly graded, having low plastic fines and a medium relative density to about 12 feet. Beyond 12 feet the material becomes more dense with fragmental sandstone and trap common. In holes 321 and 322 a more plastic mantle of silt fines is found in the first two feet. Underlying this zone the material is fine to medium grained silty sand with fragmental rock becoming more prevalent with depth. A denser zone (probably till) is found at about 10 feet. In hole 321, rock was hit at 15.5 feet and in 322 at 16.3 feet. Approximately 5 feet of rock was drilled in each hole. In hole 323, comparable materials were encountered to a depth of 12 feet where bedrock was hit and drilled. The bedrock surface is approximately 6 feet higher in elevation than was encountered in preceding holes. Hole 324 which is at the approximate outlet was drilled to a depth of 16.8 feet without hitting bedrock. The materials and conditions encountered are similar to those previously described. Bedrock where drilled is a fine grained, red, micaceous sandstone.

Constant head permeability tests were conducted in holes 321, 322, and 323. The following summarizes test results:

Hole No.	Depth (feet)	k Values (ft/day)
321	5.0-7.0	0.03
321	10.0-11.5	0.04
322	5.0-7.0	0.07
323	5.0-7.0	0.05

Test results indicate only a slight "k" value with very little range in the data obtained. It should be noted that in hole 323 a 1.3 foot artesian head was maintained when the casing was advanced to and set at 10.0 feet. This head was maintained for 0.5 hours without any

measurable head loss. Groundwater levels in all holes drilled along the centerline of the principal conduit were at or within one foot of existing ground surface. With the groundwater level so identified, the estimated rate of recharge is high.

C. Emergency Spillway

The emergency spillway is planned for the right side. Having a proposed bottom width of 300 feet, a substantial excavation will be required to accommodate the spillway with its required side-slopes. The centerline of the control section is tentatively a projection of the centerline of dam. The centerline of the emergency spillway intersects the centerline of the dam at station 7+80. Hence, 7+80 (centerline dam) equals 6+00 (centerline emergency spillway).

A total of 11 holes were drilled in the emergency spillway area to evaluate subsurface materials and conditions. All holes were drilled below the anticipated construction grade; either directly on or on both sides of the control section. In addition, several holes were drilled beyond the proposed bottom limits of the spillway to determine the nature of the materials in which the outer side slopes of the spillway are to be located. The unconsolidated materials overlying sandstone are markedly similar. They are fine to medium grained sands, poorly graded, slightly micaceous and exhibit little to no plasticity. Fragmental sandstone associated with minor trap becomes more common with increased hole depth. With the exception of hole 222 where groundwater had a measured depth of 6.1 feet, all holes drilled in the emergency spillway were dry.

Holes 220, 224, 227 and 229 (Section C-C) were drilled in the proposed control section on the projected centerline of the dam. Holes 220 and 224 encountered bedrock 6 feet and 6.5 feet respectively below the crest elevation of the spillway which is planned at elevation 102. Hole 220 was advanced through about 4.5 feet of red sandstone with the hydraulic power-auger. Hole 224 (centerline of dam and emergency spillway) bottomed at 15.8 feet which was the zone of refusal to the split-spoon sampler. Hole 229 is located within the proposed bottom width of the spillway approximately 25 feet from the outer cut limits. Bedrock was drilled from elevation 109 or 7 feet above construction

GEOLOGY REPORT

grade and a six (6) foot penetration made. Hole No. 227 is located about 25 feet beyond the limits of the bottom spillway cut. Bedrock was drilled from 113.5 with a 7 foot penetration being made. This will be within the projected outer side slope limits of the spillway.

Holes 221, 225, 228 and 230 (Section D-D) were drilled across the approximate entrance channel to evaluate the sub-strata and delineate bedrock where present. Holes 221 and 225 each penetrated unconsolidated materials extending about 3.5 feet below anticipated grade. Hole 228 although about 80 feet beyond the outer limits of the emergency spillway, provided information for bedrock correlation. Sandstone was hit and cored from elevation 112 for a 5.5 foot penetration. In hole 230 which is approximately at the outer limit of the spillway cut, bedrock was hit at elevation 106.5.

Holes 222, 223 and 226 (Section B-B) crossed a portion of the exit channel approximately 145 feet downstream from the control section. No bedrock was hit down to the proposed grade elevation. Hole 226 was drilled as close to the outer limits of the spillway as existing topography would allow. However, its location is about 55 feet shy of the outer edge. Soft red sandstone was hit 4 feet below grade in hole 226 at elevation 95±. The hydraulic auger made a 3 foot penetration at which point no further advance could be made.

If the emergency spillway is to be constructed at its present location and grades, the following estimates for the volume of excavation have been computed:

Common Excavation	50,718 cubic yards
Rock	6,310 cubic yards
Total Excavation	57,028 cubic yards

The total volume of excavation was computed from several planimetered cross sections to excavation grade multiplied by the distances and/or widths involved. Several methods were used in determining the rock to be excavated. The method used was based on projecting then delineating bedrock limits in plan view and multiplying by the average thickness of rock at the outer limit of the excavation.

GEOLOGY REPORT

The average thickness of rock is based on the difference in elevation between the proposed excavation grade and the elevation at which actual rock core drilling commenced. In holes where no rock core drilling was performed, the depth to rock was based on blow count, the inability to advance the sampling device (refusal), the degree of augering difficulty and/or the type of auger returns. In most cases, several of the aforementioned were utilized to arrive at bedrock depth or elevation.

D. Borrow Area

No extensive borrow investigations were undertaken since ample borrow will be available from the emergency spillway excavation. However, three holes (120, 121, and 122) were drilled on the right side as a possible secondary source area. A sample from a backhoe pit was taken from the emergency spillway area. The sample (No. 130) was taken about 50 feet north of centerline dam, Station 9+0. The material tentatively identified as SM is thought to be representative not only of the emergency spillway area but also of the material found on the whole right side as evidenced in holes 120 and 121. Both holes went to 15 feet with refusal at that depth. The materials encountered were primarily fine grained sands,poorly graded, red, trace of mica and fines exhibiting little to no plasticity. Borrow in this secondary source area has available well over 18,000 cubic yards. Limits have arbitrarily been set as to availability but using a 9 foot depth, at least 10,000 cubic yards are available up to the 106 foot contour and over 18,400 cubic yards up to the 110 foot contour. These borrow limits can be extended laterally or in the upstream and downstream direction if so desired.

BIBLIOGRAPHY

1. "Recommended Guildelines for Safety Inspection of Dams", Department of the Army, Office of the Chief Engineers, Washington, D.C. 20314, 1979.

2. Design of Small Dams, Revised Reprint, United States Department of the Interior, Bureau of Reclamation, United States Government Printing Office, Washington, D.C.

3. Soil Survey, Hartford County, Connecticut, United States Department of Agriculture, U.S. Government Printing Office, Washington 25, D.C. 1962

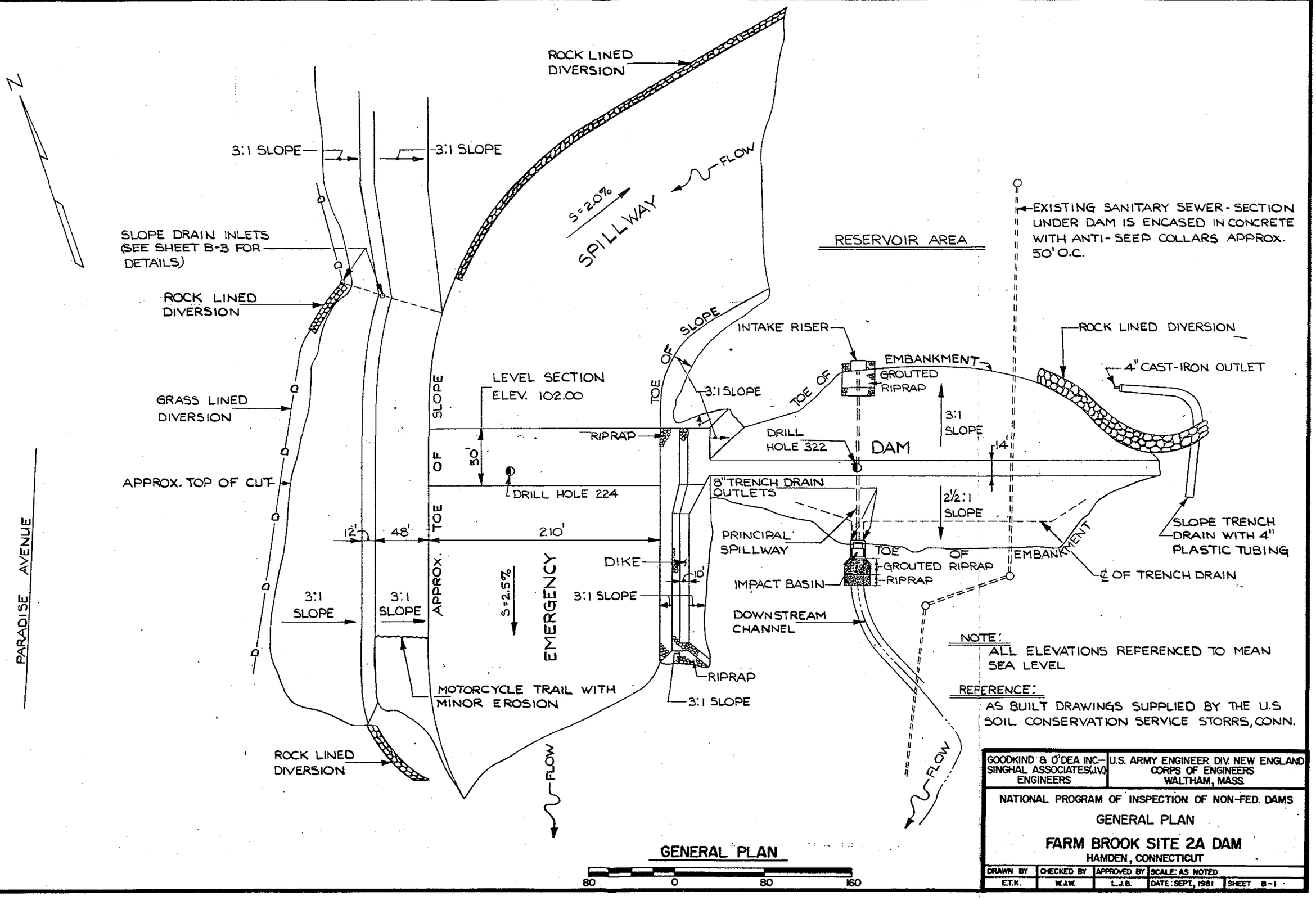
4. Donald M. Gray: Handbook on the Principles of Hydrology, Water Information Center, 1970.

5. Hunter Rouse: Engineering Hydraulics, John Wiley and Sons, New York, 1950.

6. Victor L. Streeter: Fluid Mechanics, McGraw-Hill Book Company, Inc. 1958.

7. S.C.S. National Engineering Handbook, Hydrology Section 4, Soil Conservation Service, U.S. Department of Agriculture, 1972.

8. "Design Report Farmbrook, Site No. 2." U.S. Department of Agriculture, Soil Conservation Service - Storrs, Ct. 1971.



GOODKIND & O'DEA INC.—SINGHAL ASSOCIATES (J.V.) ENGINEERS

U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

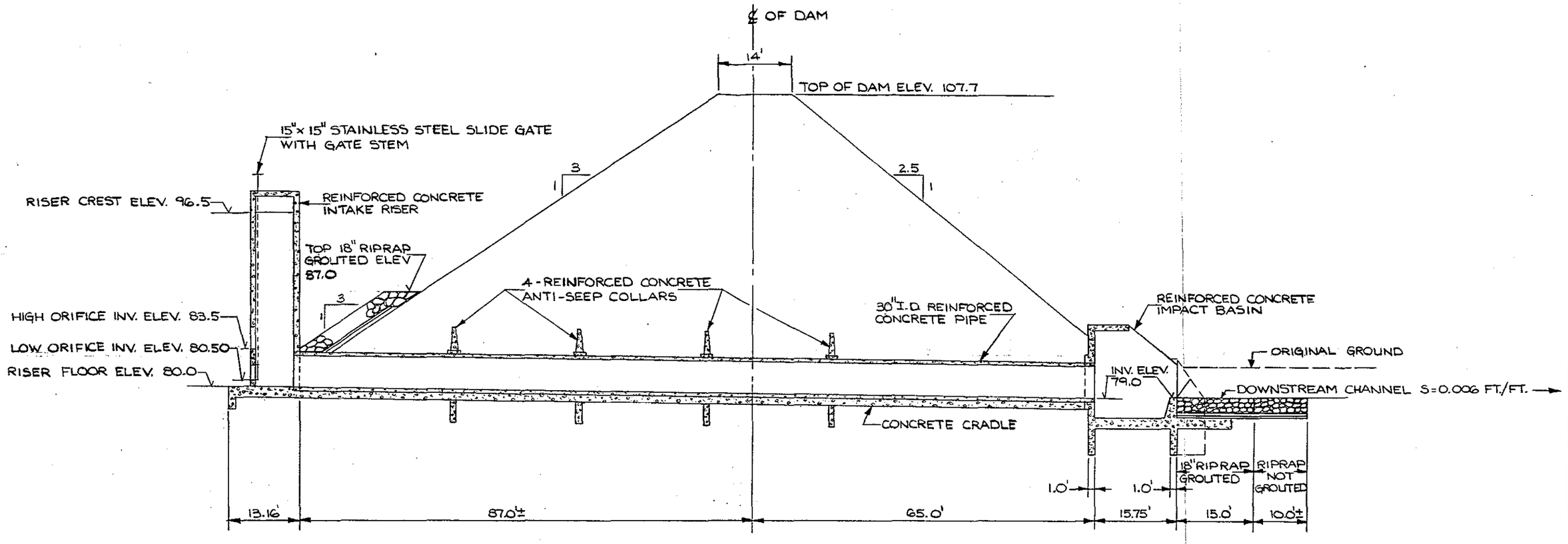
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

GENERAL PLAN

FARM BROOK SITE 2A DAM

HAMDEN, CONNECTICUT

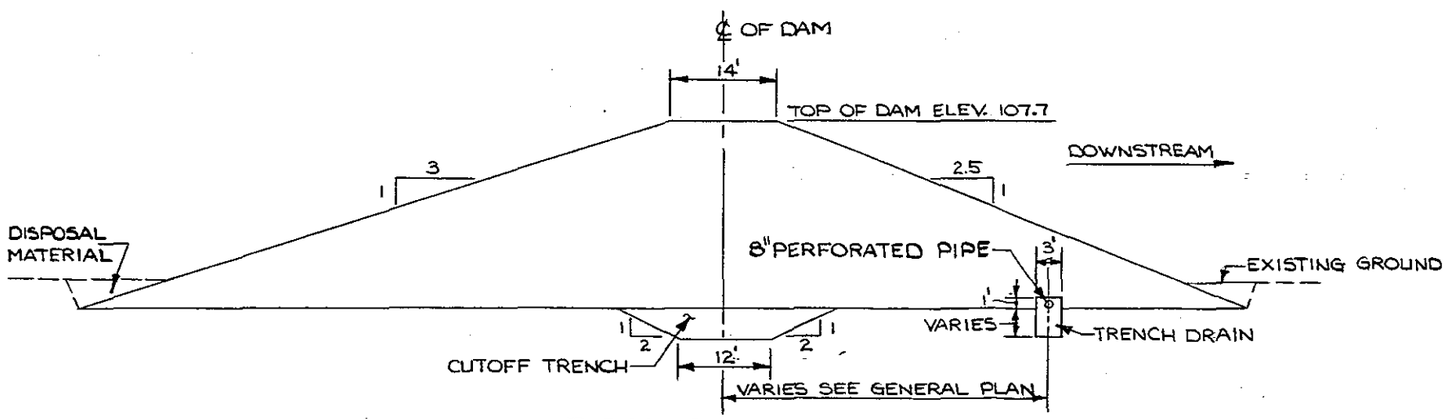
DRAWN BY	CHECKED BY	APPROVED BY	SCALE: AS NOTED	
E.T.K.	W.J.W.	L.J.B.	DATE: SEPT, 1981	SHEET B-1



PROFILE ALONG ℄ OF PRINCIPAL SPILLWAY

HORIZONTAL 20 0 20 40

VERTICAL 10 0 10 20



TYPICAL SECTION OF DAM

20 0 20 40

NOTE:
ALL ELEVATIONS REFERENCED TO MEAN SEA LEVEL.

REFERENCE:
AS BUILT DRAWINGS SUPPLIED BY THE U.S. SOIL CONSERVATION SERVICE STORRS, CONN.

GOODKIND & O'DEA INC.–SINGHAL ASSOCIATES (J.V.) ENGINEERS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

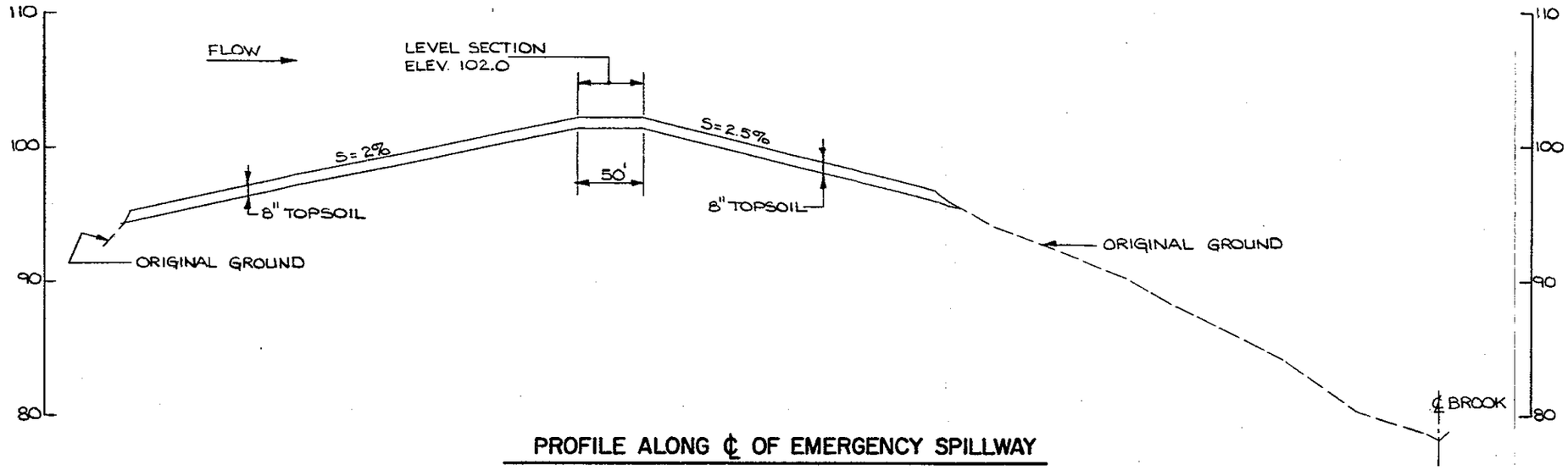
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

TYP. DAM SECTION & PROFILE OF PRINCIPAL SPILLWAY

FARM BROOK SITE 2A DAM

HAMDEN, CONNECTICUT

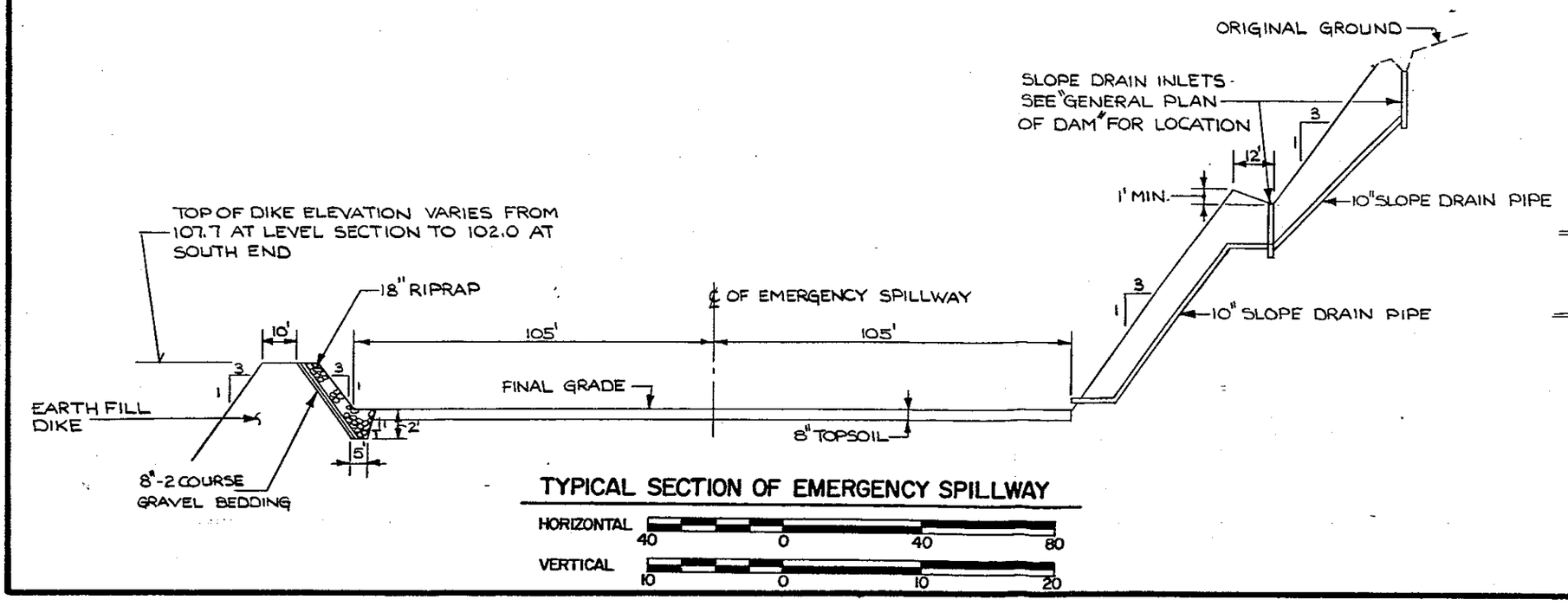
DRAWN BY	CHECKED BY	APPROVED BY	SCALE: AS NOTED	
E.T.K.	W.J.W.	L.J.B.	DATE: SEPT., 1981	SHEET B-2



PROFILE ALONG ℄ OF EMERGENCY SPILLWAY

HORIZONTAL 100 0 100 200

VERTICAL 10 0 10 20



TYPICAL SECTION OF EMERGENCY SPILLWAY

HORIZONTAL 40 0 40 80

VERTICAL 10 0 10 20

NOTE:

ALL ELEVATIONS REFERENCED TO MEAN SEA LEVEL.

REFERENCE:

AS BUILT DRAWINGS SUPPLIED BY THE U.S. SOIL CONSERVATION SERVICE STORRS, CONN.

GOODKIND & O'DEA INC.—SINGHAL ASSOCIATES (J.V.) ENGINEERS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

TYP. SECTION & PROFILE OF EMERGENCY SPILLWAY

FARM BROOK SITE 2A DAM

HAMDEN, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE: AS NOTED	
E.T.K.	W.J.W.	L.J.B.	DATE: SEPT., 1981	SHEET B-3

DH-224, Elev. 110.9, Sta. 7+80 *

* 7+80 Centerline Dam

N = 5 — Topsoil

Hole Dry - 5/19/67

54

SM

10 → Blows 0.8'

Entire hole section:
Predominantly weathered siltstone, sandstone and trap fragments w/fine to medium, poorly graded sand, red, trace of mica.

53

SM

50/TD Blows for 0.3'

TD - 15.8'

DH-322, Elev. 80.6, Sta. 4+65*

* Centerline Principal Spillway & Dam

N = 3 SM-ML — ▽ W.L. - 4/17/67

Sand, very fine grained

29 SP-SM — Sand, very fine to fine grained, poorly graded, red to brown.

19 ← 5-7' : k = 0.072 ft/day

SM — Sand, fine grained, poorly graded, red, some mica, weathered fragmental sandstone from 10.0'

95

136

NX Ss

62%

TD - 21.2'

NOTE:

1.) ALL ELEVATIONS REFERENCED TO MEAN SEA LEVEL.

2.) SEE SHEET B-1 "GENERAL PLAN OF DAM" FOR DRILL HOLE LOCATIONS.

3.) SEE AS BUILT DRAWINGS FOR ADDITIONAL SUBSURFACE SOIL DATA.

REFERENCE:

AS BUILT DRAWINGS SUPPLIED BY U.S. SOIL CONSERVATION SERVICE STORRS, CONN.

GOODKIND & O'DEA INC.–SINGHAL ASSOCIATES, (J.V.) ENGINEERS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

TYPICAL DRILL HOLES

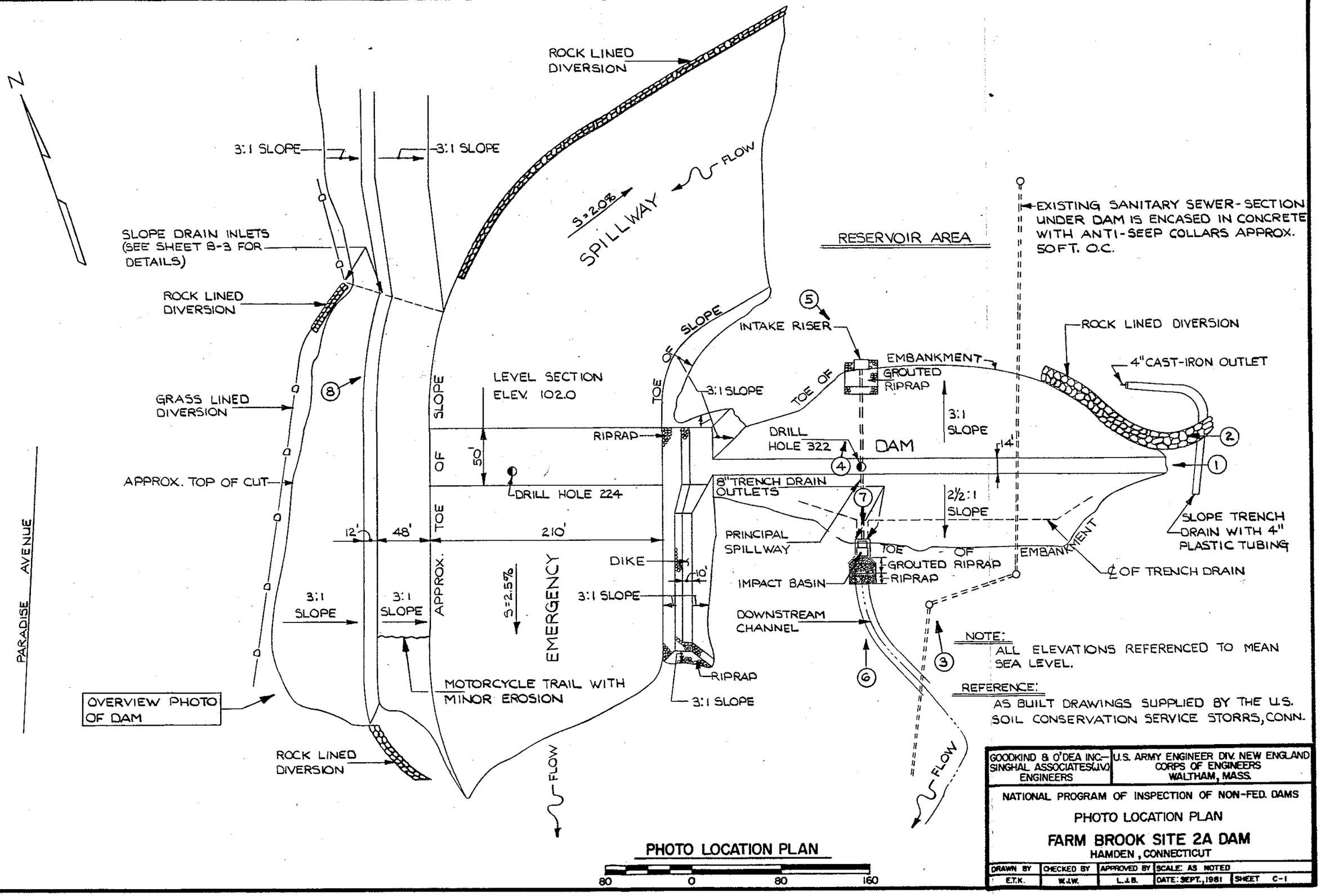
FARM BROOK SITE 2A DAM

HAMDEN, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE: NONE	
E.T.K.	W.J.W.	L.J.B.	DATE: SEPT., 1981	SHEET B-4

APPENDIX C

DETAIL PHOTOGRAPHS



GOODKIND & O'DEA INC—SINGHAL ASSOCIATES(J.V.) ENGINEERS

U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PHOTO LOCATION PLAN

FARM BROOK SITE 2A DAM

HAMDEN, CONNECTICUT

DRAWN BY	CHECKED BY	APPROVED BY	SCALE: AS NOTED	
E.T.K.	W.J.W.	L.J.B.	DATE: SEPT., 1981	SHEET C-1

Photo 1 - View looking west along crest of dam. Note vehicular tracks with exposed earth areas.

Photo 2 - Upstream slope of dam and west side slope of emergency spillway.

Note:
Photos taken June 2, 1981

Photo 3 - View of downstream slope of dam embankment. Note vehicular trails.

Photo 4 - Upstream reservoir area with principal spillway in foreground.

Note:
Photos taken June 2, 1981

Photo 5 - Two Stage reinforced concrete intake riser. Note grouted riprap area.

Photo 6 - Reinforced concrete impact basin. Note tilted fence.

Note:
Photos taken June 2, 1981

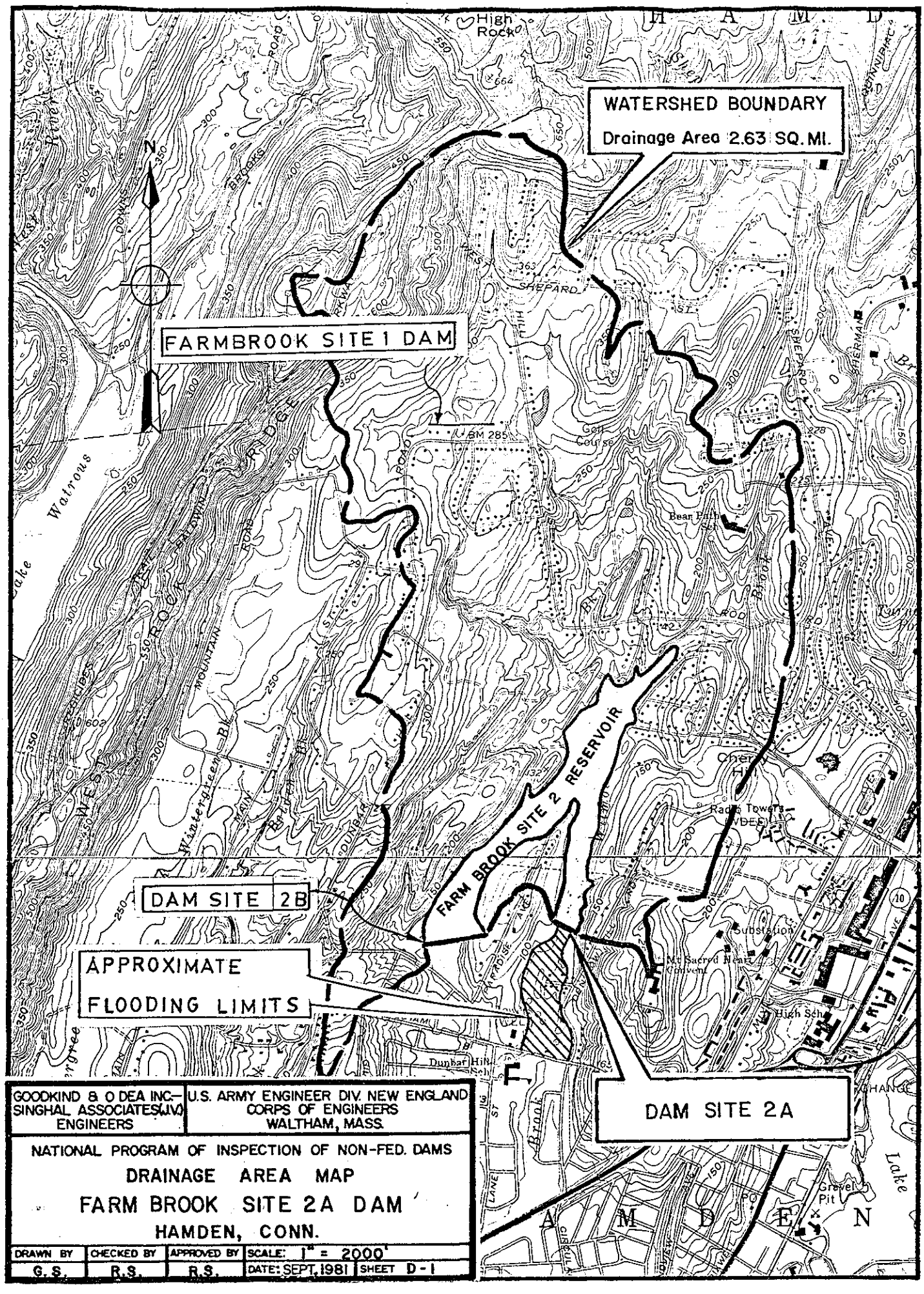
Photo 7 - Downstream Channel with impact basin in foreground. Note cracked concrete at base of fence posts.

Photo 8 - View looking at approach channel of emergency spillway. Note vehicular trail.

Note:
Photos taken June 2, 1981

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS



GOODKIND & O'DEA INC.—SINGHAL ASSOCIATES (J.V.) ENGINEERS	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

DRAINAGE AREA MAP

FARM BROOK SITE 2A DAM

HAMDEN, CONN.

DRAWN BY	CHECKED BY	APPROVED BY	SCALE: 1" = 2000'
G. S.	R.S.	R.S.	DATE: SEPT. 1981 SHEET D-1

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)
827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A
Sheet Number D-1
Date 7.14.1981
By R.S./G.S.

TEST- FLOOD

THE PROJECT RECEIVES RUNOFF FROM A DRAINAGE AREA OF 2.63 SQ. MILES. THE TERRAIN HAS AN AVERAGE SLOPE OF 4.6%.

AS PER THE CORPS OF ENGINEER' CHART A FACTOR OF 1500 CFS/SQ. MI BETWEEN 'ROLLING' AND FLAT & COASTAL TERRAIN WAS SELECTED.

RUNOFF = 1500 X 2.63 = 3945 CFS.

ADDING FARMBROOK SITE #1 DAM BREACH OUTFLOW OF 2000 CFS
TOTAL PMF. = 3945 +2000 = 5945 SAY 6000 CFS.

SIZE AND HAZARD CLASSIFICATION

MAXIMUM HEIGHT OF DAM = 29 FT.
MAXIMUM IMPOUNDMENT UPTO TOP OF DAM = 1190 AC.FT.

THE IMPOUNDMENT LIES BETWEEN THE LIMITS 1000 AC. FT. AND 50,000 AC-FT. AS SUCH THE SIZE OF THE DAM = "INTERMEDIATE" ALTHOUGH THE HEIGHT OF THE DAM DOES NOT EXCEED 40 FT.

THE HAZARD POTENTIAL IS 'HIGH' DUE TO THE EXISTENCE OF MANY STREETS, ROADS, PUBLIC AND PRIVATE BUILDINGS THAT WILL BE FLOODED IN THE EVENT OF DAM FAILURE. THERE IS POTENTIAL FOR 'EXCESSIVE' ECONOMIC LOSS IN ADDITION TO LOSS OF 'MORE THAN FEW' LIVES.

AS PER TABLE 3 PAGES D-12, D-13 OF "THE RECOMMENDED GUIDELINES FOR SAFETY INSPECTION OF DAMS" THE RECOMMENDED TEST FLOOD

= PMF

= 6,000 CFS.

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)

827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A
Sheet Number D-2
Date 7-14-1988
By R.S./G.S.

SPILLWAY CAPACITY (SITE 2A)

THE SPILLWAY AT SITE 2A CONSISTS OF THE FOLLOWING :

1- 30" RC WATER PIPE (INV. 80.0) WITH
ONE 1.25'x1.25' LOW. ORIFICE (INV. 80.5)
ONE 2'x2' HIGH. ORIFICE (INV. 83.5)
15' WIDE RISER WEIR (CREST ELEV. 96.5)

1- EMERGENCY SPILLWAY 210' WIDE AT THE CONTROL SECTION, WITH CREST ELEVATION 102.0

SPILLWAY CAPACITIES AT VARIOUS ELEVATIONS FOR SITE 2A ARE TABULATED BELOW :

ELEVATION	SPILLWAY CAPACITY (SITE 2A) - CFS		
	PRINCIPAL SPILLWAY	EMERGENCY SPILLWAY $Q = 3 \times 210 \times H^{3/2}$	TOTAL
96.5	100	0	100
98.0	103	0	103
99.0	106	0	106
100.0	109	0	109
101.0	112	0	112
102.0	115	0	115
103.0	117	630	747
104.0	120	1780	1900
105.0	122	3273	3395
106.0	125	5040	5165
107.0	127	7043	7170
107.7	130	8570	8700

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)

827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A
Sheet Number D-3
Date 7-14-1981
By R.S./G.S.

SPILLWAY CAPACITY (SITE 2B)

THE SPILLWAY AT SITE 2B CONSISTS OF THE FOLLOWING:

1- 30" RC WATER PIPE (INV. 82.0)
ONE 1.25'X1.25' LOW ORIFICE (INV. 82.5)
ONE 1'X2' HIGH ORIFICE (INV. 85.5)
15' WIDE RISER. WEIR (CREST ELEV. 96.5)

1- EMERGENCY SPILLWAY 90' WIDE AT THE CONTROL SECTION, WITH CREST ELEV. 102.0

SPILLWAY CAPACITIES AT VARIOUS ELEVATIONS FOR SITE 2B ARE TABULATED BELOW:

ELEVATION	SPILLWAY CAPACITY (SITE 2B) – CFS		
	PRINCIPAL SPILLWAY	EMERGENCY SPILLWAY $Q = 3 \times 90 \times H^{3/2}$	TOTAL
96.5	100	0	100
98.0	103	0	103
99.0	106	0	106
100.0	109	0	109
101.0	112	0	112
102.0	115	0	115
103.0	117	270	387
104.0	120	765	885
105.0	122	1403	1525
106.0	125	2160	2285
107.0	127	3018	3145
107.7	130	3670	3800

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)
827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITES 2A
Sheet Number D-4
Date 7-15-1981
By R.S./G.S.

COMBINED SPILL WAY CAPACITY OF SITE 2 (SITE 2A + SITE 2B)

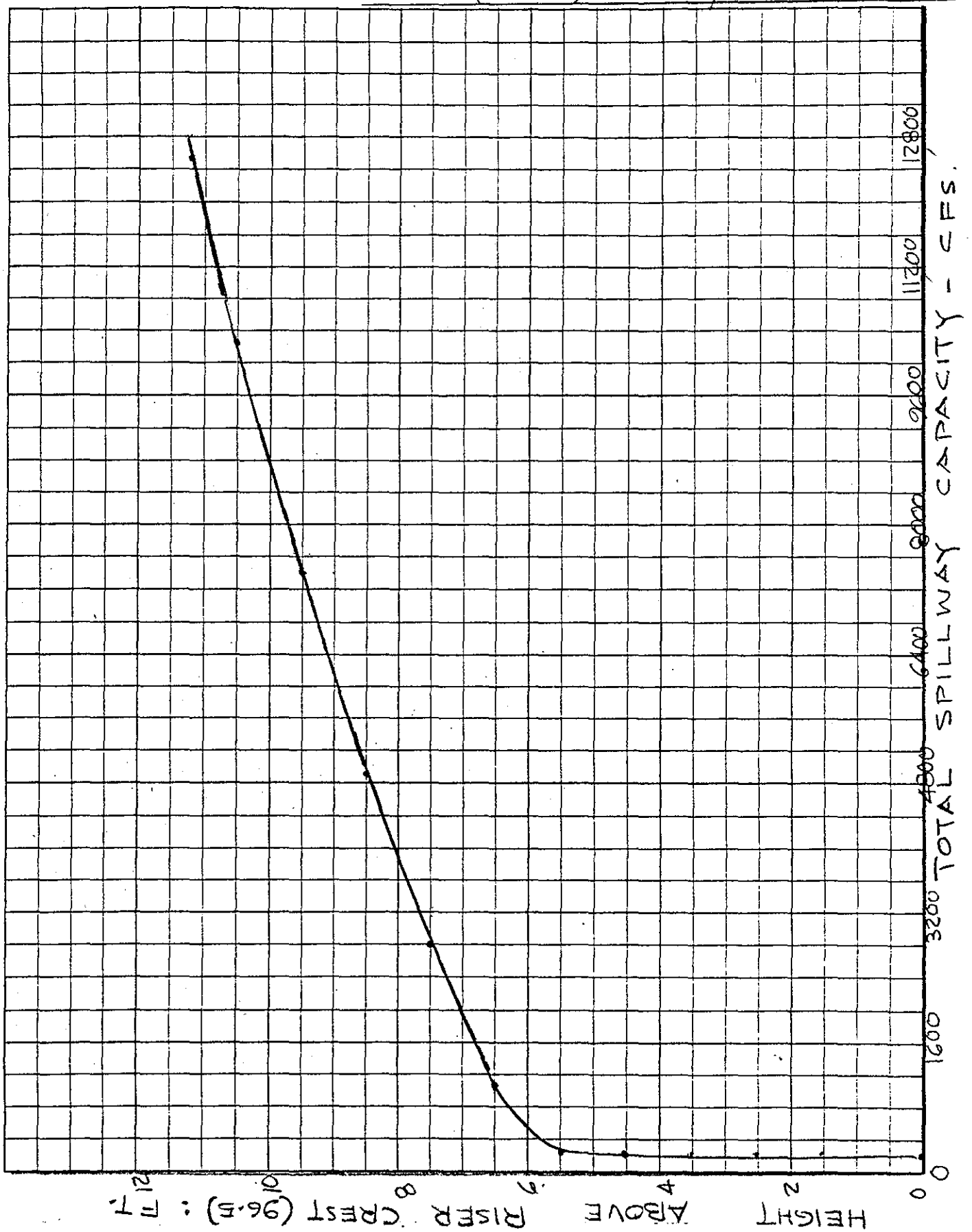
ELEVATION	SPILLWAY CAPACITY SITES 2A+2B (CFS)		
	PRINCIPAL SPILL WAYS	EMERGENCY SPILL WAYS	TOTAL
96.5	200	0	200
98.0	206	0	206
99.0	212	0	212
100.0	218	0	218
101.0	224	0	224
102.0	230	0	230
103.0	234	900	1134
104.0	240	2,545	2,785
105.0	244	4676	4920
106.0	250	7,200	7,450
107.0	254	10061	10,315
107.7	258	12,246	12,500

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)

827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A
Sheet Number D-5
Date 7.15.1981
By DS/GS.

SITE 2 (2A+2B) SPILLWAY CAPACITY CURVE



SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)

827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

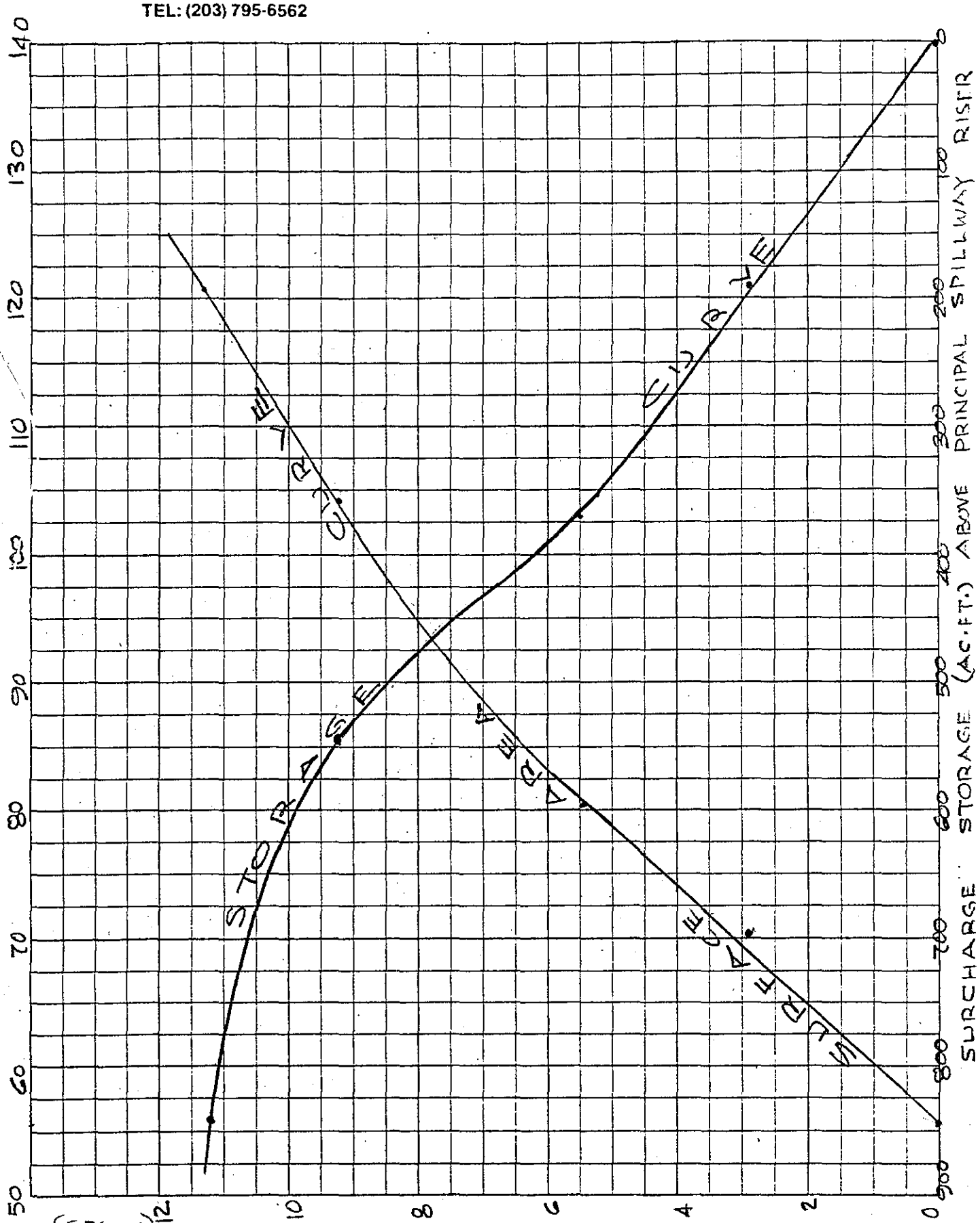
Job FARMBROOK SITE 2A
Sheet Number D-6
Date 7-15-1981
By R.S./G.S.

SURCHARGE STORAGES AND WATER SURFACE AREAS FOR THE RESERVOIR

RESERVOIR WATER SURFACE ELEVATION	HEIGHT ABOVE RISER CREST OF EMERGENCY SPILLWAY (FT.)	WATER SURFACE AREA (ACRES)	SURCHARGE STORAGE CAPACITY (AC-FT.)
96.5	0.0	56.0	0.0
98.0	1.5	63.0	100.0
99.0	2.5	68.0	175.0
100.0	3.5	72.0	237.0
101.0	4.5	77.0	310.0
102.0	5.5	80.0	372.0
103.0	6.5	86.0	412.0
104.0	7.5	92.0	450.0
105.0	8.5	98.0	500.0
106.0	9.5	107.0	570.0
107.0	10.5	113.0	675.0
107.7	11.2	120.0	842.0

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)
827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A
Sheet Number D-7
Date 7-15-1981
By R.S./G.S.



SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)
827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

FARMBROOK SITE 2A
Job
Sheet Number D-8
Date 7.22.1981
By R.S./G.S.

INFLOW FLOOD HYDROGRAPH

TEST FLOOD (P.M.F.) = 6,000 CFS.
DRAINAGE AREA = 2.63 SQ. MILES.

AS PER 'HYDROLOGY, SECTION 4, S.C.S. NATIONAL ENGINEERING HANDBOOK',

$$q_p = \frac{484 \cdot A \cdot Q}{T_p}$$

AND $T_b = 2.67 \times T_p$

WHERE T_b = TIME BASE OF HYDROGRAPH IN HOURS

T_p = TIME IN HOURS FROM START OF RISE OF HYDROGRAPH TO ATTAINMENT OF PEAK.

q_p = PEAK RATE OF RUNOFF IN CFS.

A = DRAINAGE AREA IN SQUARE MILES

Q = TOTAL RUNOFF IN INCHES

SUBSTITUTING KNOWN VALUES OF A, Q AND q_p:

$$6{,}000 = \frac{484 \times 2.63 \times 19}{T_p}$$

FROM WHICH T_p = 4 HOURS

AND $T_b = 2.67 \times 4 = 10.7$ HOURS
SAY 11 HOURS

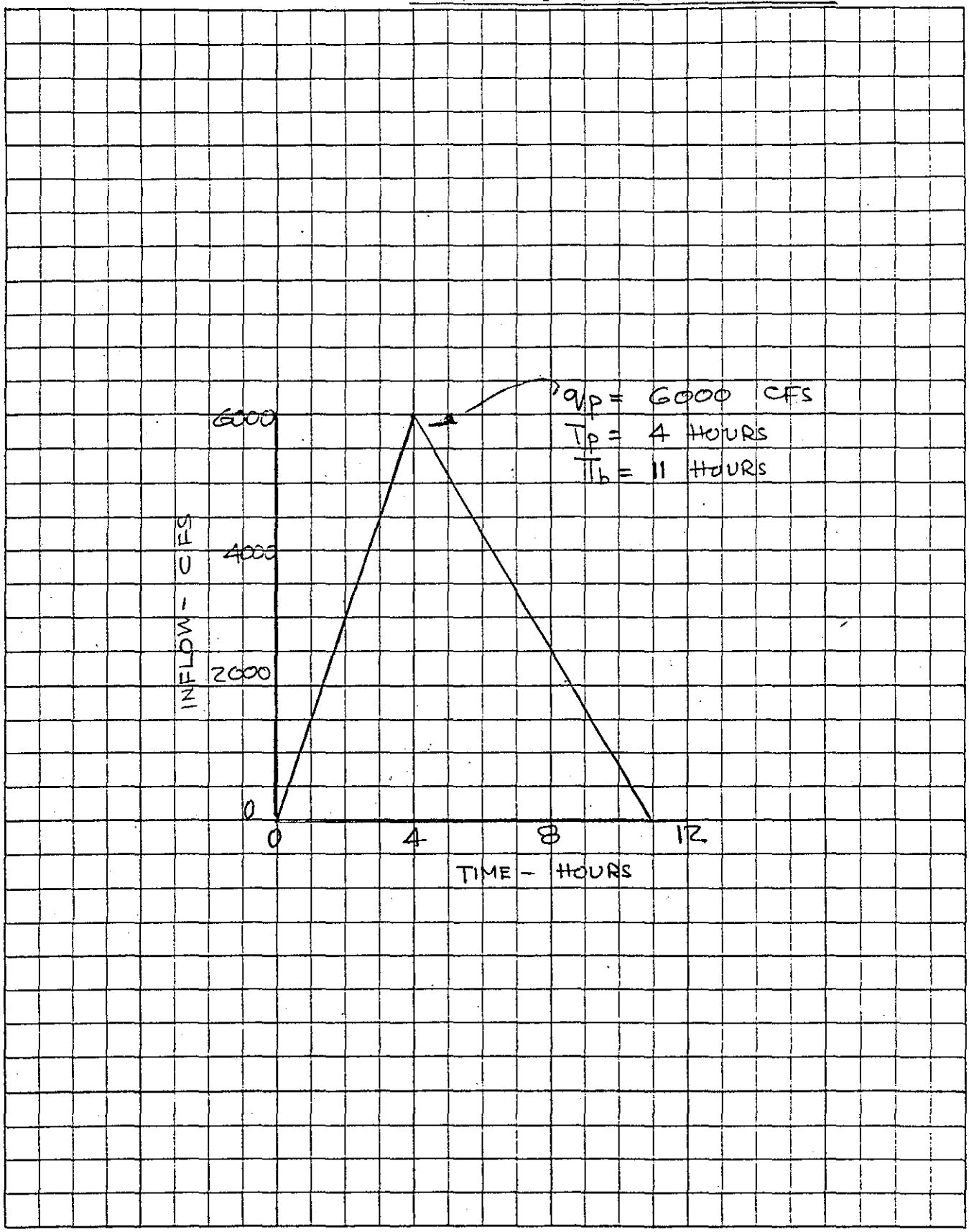
THE TRIANGULAR HYDROGRAPH ON THE FOLLOWING PAGE HAS BEEN DRAWN ACCORDINGLY.

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)

827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A
Sheet Number D-9
Date 8-31-1981
By R.SINGHAL

INFLOW HYDROGRAPH



SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)

827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

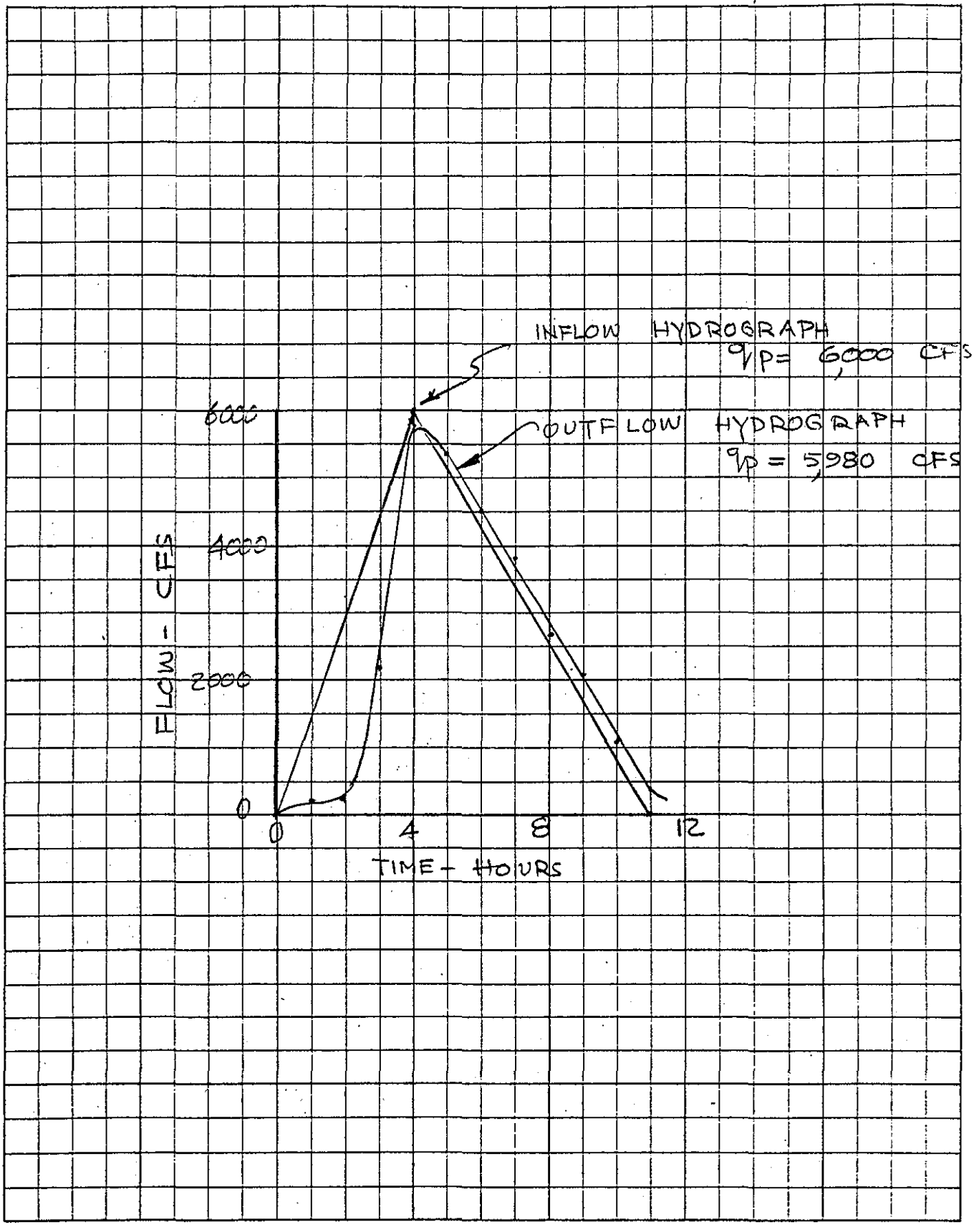
Job FARMBROOK SITE 2A
Sheet Number D-10
Date 8-31-1981
By R. SINGHAL

TIME (HRS)	TIME (HRS)	INFLOW RATE (CFS)	INFLOW (AC-FT.)	RESERVOIR ELEVATION AT END OF ΔT	END OF ΔT	AVG. FOR ΔT	FOR ΔT (AC-FT.)	TOTAL STORAGE ΔS (AC-FT.)	STORAGE (AC-FT.)	ELEVATION AT END OF ΔT
0				~~96.60~~	~~200~~	~~140~~	~~8~~	~~55~~	~~55~~	~~97.30~~
	1	750	63	97.30	203	102	9	54	54	97.30
	1	2250	188	~~99.5~~	~~215~~	~~209~~	~~17~~	~~171~~	~~225~~	~~99.8~~
2				99.80	217	210	18	170	224	99.80
	1	3750	313	~~102.9~~	~~1124~~	~~672~~	~~56~~	~~257~~	~~481~~	~~104.60~~
3				103.65	2207	12112	101	212	436	103.63
	1	5250	438	~~105.0~~	~~4920~~	~~3564~~	~~297~~	~~141~~	~~577~~	~~106.60~~
4				105.40	5980	4095	342	96	532	105.40
	1	5570	464	~~105.0~~	~~4920~~	~~5439~~	~~457~~	~~7~~	~~537~~	~~105.50~~
5				105.20	5426	5742	472	-15	515	105.20
	1	4715	393	~~105.00~~	~~4920~~	~~5173~~	~~431~~	~~-78~~	~~477~~	~~104.50~~
6				104.80	4493	4960	413	-20	495	104.90
	1	3860	322	104.50	3853	4173	348	-26	469	104.40
7				~~104.00~~	2735	3319	277	~~-27~~	442	103.80
	1	3000	250	102.90	2620	3236	270	-20	449	104.00
8				~~103.50~~	1960	2290	191	~~-13~~	436	~~103.63~~
	1	2140	178	103.55	2042	2331	194	-16	423	103.55
9				103.00	1134	1588	132	-25	408	103.00
	1	1285	107							
10				~~102.50~~	~~684~~	~~908~~	~~76~~	-40	~~368~~	~~102.60~~
	1	430	36							
11				102.20	411	772	64	~~-28~~	380	102.20

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)
827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A
Sheet Number D-11
Date 8.31.1981
By R-SINGHAL

INFLOW AND OUTFLOW HYDROGRAPHS



SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)
827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A DAM
Sheet Number D-12
Date 7.23.1981
By R.S./G.S.

DAM FAILURE FLOOD ROUTING

AS PER CORPS OF ENGINEERS' GUIDELINES:

$$Q_{P_1} = \frac{8}{27} \cdot W_b \cdot \sqrt{2g} \cdot y_o^{3/2}$$

WHERE Q_{P_1} = DAM FAILURE PEAK OUTFLOW IN CFS

W_b = BREACH WIDTH = 40% OF DAM LENGTH AT MID-HEIGHT

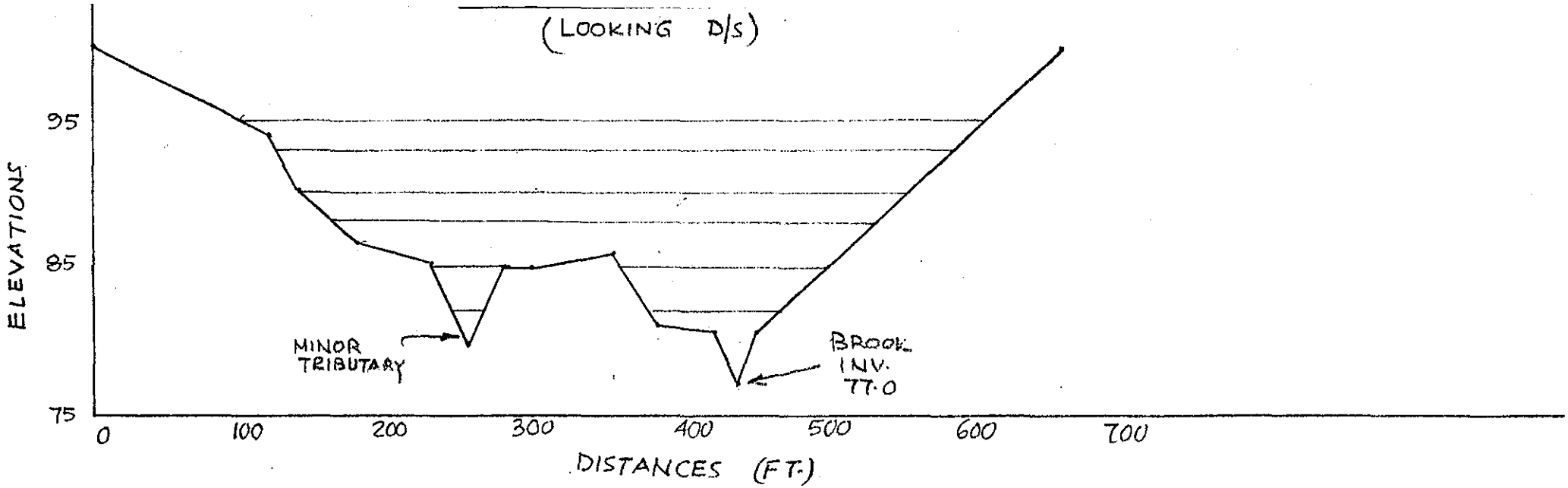
Y_o = HEIGHT FROM STREAM-BED TO POOL LEVEL AT FAILURE (103.8)

SUBSTITUTING THE VALUES OF W_b AND Y_o AS $(0.4 \times 440')$ AND $28'$:

$$Q_{P_1} = \frac{8}{27} \cdot (0.4 \times 440') \times \sqrt{32.2} \times 28^{3/2}$$

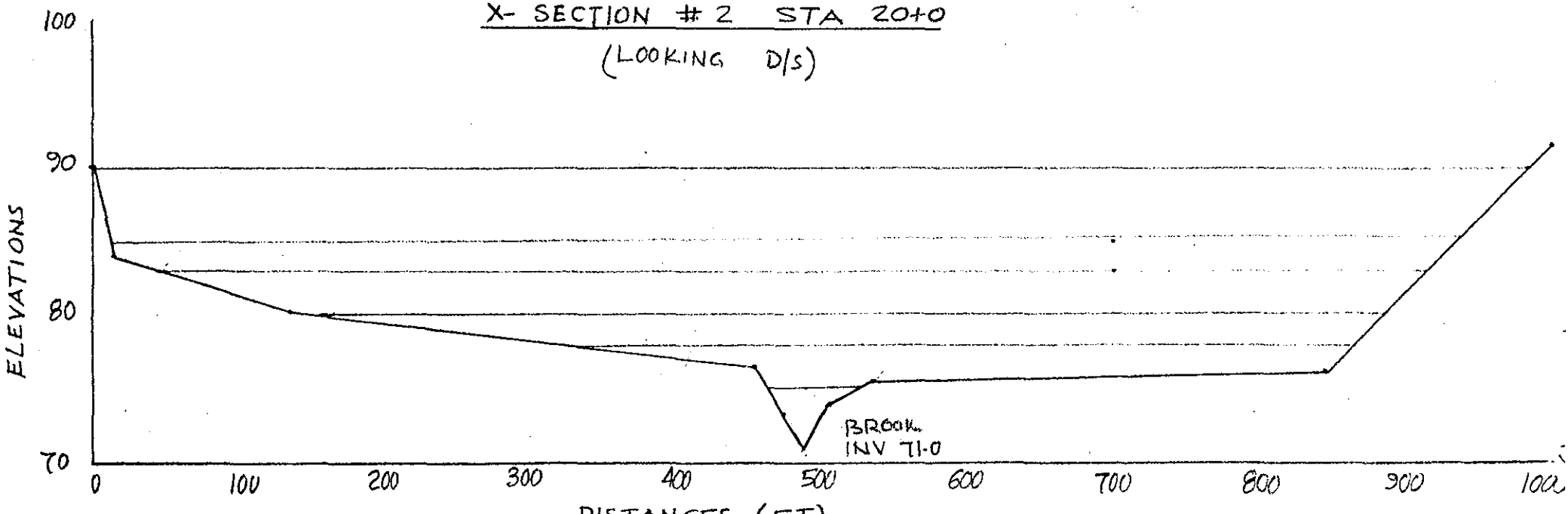
$$= 35{,}080 \quad \text{SAY} \quad \underline{\underline{44{,}000}} \text{ CFS}$$

(LOOKING D/S)



X- SECTION # 2 STA 20+0

(LOOKING D/S)



SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)
827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A DAM
Sheet Number D-14
Date 7.24.1981
By R.S./G.S.

X-SECTION #1 STA. 3+0

ELEV.	D (FT.)	Pw (FT)	A (S.F)	R = (A/Pw) FT.	S (FT./FT.)	V = 1.486 R^2/3 S^1/2 / n (FT./SEC.)	Q (CFS)
77.0	0	-	-	-	-	-	-
82.0	5	110	170	1.55		3.50	595
85.0	8	190	620	3.26		5.75	3565
88.0	11	370	1580	4.27		6.88	10870
					.0038		
90.0	13	410	2360	5.76		8.40	19825
93.0	16	460	3665	7.97		10.43	38225
95.0	18	510	4635	9.09		11.39	52800

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)

827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A DAM
Sheet Number D-15
Date 7-24-1981
By R.S./G.S.

X-SEC. #2 STA. 20+0

ELEV.	D (FT).	P_w (FT.)	A (S.F.)	$R = A/P_w$ (FT.)	S (FT/FT.)	$V = \frac{1.486}{n} R^{2/3} S^{1/2}$ (FT./SEC.)	Q. (CFS)
71.0	0	-	-	-	-	-	-
75.0	4	60	100	1.67		3.68	368
78.0	7	530	1272	2.40		4.69	5965
80.0	9	730	2532	3.47		6.00	15200
					.0038		
83.0	12	870	4932	5.67		8.32	41000
85.0	14	925	6727	7.27		9.82	66000

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)
827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A DAM
Sheet Number D-16
Date 7/26/1981
By R.S.

DAM FAILURE FLOOD ROUTING.

X- SEC. #1. (STA 3+0)

FOR Q_{P_1} = 44,000 CFS H_1 = 16.8′ AND A_1 = 4053 SF

REACH LENGTH = 300 FT.

STORAGE VOLUME = 300 × 4053/43560 = 27.9 AC. FT.
= 0.20" OF RUNOFF

$$Q_{P2} = Q_{P_1}\left(1 - \frac{0.20}{19}\right) = 44000 \times 0.99 = 43560 \text{ CFS}$$

H_2 = 16.73′ AND A_2 = 4020 SF.

STORAGE VOLUME = 300 × 4020/43560 = 27.7 AC. FT.

AVERAGE STORAGE VOLUME = ½ (27.9 + 27.7)
= 27.8 AC. FT.
= 0.20" OF RUNOFF

THE ROUTED FLOW BELOW X- SECTION #1, WILL BE = 43,600 CFS AND H = 16.7 FT.

POST FAILURE FLOOD ELEVATION = 77.0 + 16.7 = 93.7

PRE-FAILURE FLOW = 2370 × 210/300 = 1660 CFS.
FLOW DEPTH = 6.0′
AND FLOOD ELEVATION = 77.0 + 6.0 = 83.0

RISE IN FLOOD STAGE = 93.7 − 83.0
= 10.7′
SAY 11.0′

SINGHAL ASSOCIATES
CONSULTING ENGINEERS
(CIVIL, HYDRAULICS, SANITARY)
827 MAPLEDALE ROAD, ORANGE, CT 06477
TEL: (203) 795-6562

Job FARMBROOK SITE 2A DAM
Sheet Number D-17
Date 7.26.1981
By R.S.

DAM FAILURE FLOOD ROUTING

X-SEC. #2 STA 20+0

FOR Q_{p_1} = 43600 CFS, $H_1 = 12.2'$ AND $A_1 = 5110$ SF.

REACH LENGTH = 1700 FT
STORAGE VOLUME = 1700 x 5110 / 43560 = 199 AC.FT.
= 1.4" OF RUNOFF

$$Q_{p_2} = Q_{p_1}\left(1 - \frac{1.4}{19}\right) = 43600 \times 0.926 = 40{,}400 \text{ CFS}$$

$H_2 = 12.0'$ AND $A_2 = 4900$ SF.

STORAGE VOLUME = 1700 x 4900 / 43560 = 195 AC.FT.

AVERAGE STORAGE = $\frac{1}{2}(191+199)$ = 165 AC.FT.
= 1.18" OF RUNOFF

$$Q_{p_3} = Q_{p_1}\left(1 - \frac{1.39}{19}\right) = 43600 \times 0.927 = 40{,}420 \text{ CFS}$$
SAY 40,000 CFS.

THE ROUTED FLOW BELOW X-SECTION #2 WILL BE = 40,000 CFS AND H = 12.0'

POST-FAILURE FLOOD ELEVATION = 71.0 + 12.0 = 83.0

PRE-FAILURE FLOW = 2370 x 210/300 = 1660 CFS
FLOW DEPTH = 4.7 FT.
AND FLOOD ELEVATION = 71.0 + 4.7 FT. = 75.7
SAY 76.0

RISE IN FLOOD STAGE = 83.0 − 76.0
= 7.0 FT.

NUMBER OF HOUSES FLOODED (UPTO BENHAM RD. CROSSING):
BEFORE FAILURE = 0
AFTER FAILURE = 6

APPENDIX E

INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS